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MONKEY TRAINERS AND BIRD-CATCHERS IN PATTANI, SOUTHERN SIAM.

Last August I camped for just under a week in a small wooden rest-house, recently built by the Siamese Forest Department near a way-side Railway Station, in the Southern portion of the Pattani Province, not far from the boundary of the unfederated Malay State of Kelantan.

The country is beautiful, fertile, and extremely tropical, a number of hill ranges run down the Peninsula, through this Province, but none of them attain any great heights. Both the hills and much of the plains, when not cleared for agriculture or for shifting cultivation, are covered with heavy, dense, evergreen forests, producing hardwood and softwood trees of great size and stature. The forests also produce a number of interesting and valuable minor forest products, such as gums and canes.

Agriculturally the country might almost be called a potential tropical paradise, producing as it does under regular methods of cultivation, all kinds of tropical products in abundance—such as rubber, cocoanuts, betel-nuts, the betel-nut vines, manioc, pineapples and other kinds of tropical fruits. The sago-palm abounds and the product is only used for feeding pigs and not for human consumption. In the irrigable portions there is good regular cultivation of rice, but, unfortunately, much of the country is laid waste by shifting cultivation, which as usual destroys an immense amount, to produce only a very small return.

The local population is largely Malay with a strong Chinese trading communities, and a scattered admixture of Siamese, here and there.

1.

2.

Fig. 1. A. *Phoenix sylvestris* with four branches.

3.

4.

Fig. 2. The trained monkey on a *sataw* tree in Siam.

Fig. 3. Jungli Malay bird-catchers.

Fig. 4. Malay with a monkey trained to pick coco-nuts and other fruits.

Photos 1 by E. M. Crothers, I.F.S.

2—4 by D. Bourke, I.F.S.

Whilst making excursions into the forests and round the country-side, my curiosity was at once aroused by the large numbers of tame monkeys which I saw, kept by the local Malay cultivators and fruit-farmers.

Nearly every Malay house had a tame monkey or two, tethered on the verandah or just inside the door-way, and I noticed all over the country-side the local Malays walking about with monkeys attached to long lines, trotting beside them.

On making enquiries I discovered, to my surprise, that it was the habitual practice of the local people to catch young wild monkeys and to train and use them as fruit-gatherers.

It appears that the monkeys are caught when very young and are first trained on a pole, stuck into the ground with a bunch of fruit tied to the top end ; the monkeys learn readily to climb up the pole, detach the fruit and throw it on to the ground. When the monkey is thoroughly familiar with this process, the Malay takes it out and gradually trains it on trees, until the animal becomes a real expert and will pick and throw down fruit from the tallest tree.

The monkeys are chiefly used for picking cocoanuts and *sataw* pods. The *sataw* tree *(Clarkia speciosa)* is a medium sized leguminous tree, which resembles a good deal *Albizzia* spp. It grows wild in large numbers in the Pattani forests, and is found abundantly round Malay villages and cultivations, where it is protected and probably also cultivated for the sake of its pods. The pods resemble those of *Albizzia Lebbek*, and the seed which is about the size of a broad bean, is much relished by the local people and is a common article of food all over this area. These "beans" are eaten as a vegetable, either raw or cooked in various ways.

Large and strong monkeys are needed to pick cocoanuts, as it often requires a considerable effort to detach the nuts and the monkeys sometimes have to use their teeth as well as their hands. Smaller and weaker monkeys can pick the *sataw* pods with their hands only, occasionally having recourse to their teeth. The pods grow in small clusters at the ends of the branches.

I induced a Malay to get his monkey to perform on a *sataw* tree. The monkey itself was a small greyish-brown creature, with a band round its waist and a strong coir line, like a very thick fishing line attached to it. The monkey's owner had many feet of this line coiled round a reel, closely resembling a large fishing reel, made of extremely finely woven rattan canes. Photo No. 4 on plate I shows the Malay and his trained monkey.

On the order being given to climb, the little monkey ran up the tree with considerable zest, the owner down below in the meanwhile letting the line run out in fisherman fashion.

The monkey having got into the crown of the tree, ran out on to the ends of the branches, picked off the *sataw* pods and threw them down, with great rapidity, and whenever it showed any disposition to "slack" or to shirk its job, the owner could at once rouse it to a sense of duty again, by word of mouth, emphasised by sharp tugs at the end of the line.

It is said that these trained monkeys can pick as much as a man in the course of a day's work, so the fortunate owners can thus earn a full day's wages with a minimum amount of trouble to themselves.

When I tried to get the owner to entice the monkey down on to the lowest branch of the tree to photograph it, I was much amused to see that the monkey, after quickly examining the branch and finding no pods at the end of it, flatly declined to go along it at all.

Photo No. 2 shows the little monkey on the *sataw* tree, on *its way down* after the performance, but as the monkey is very small and the tree pretty large, it is difficult to make out the monkey in the photo, in fact it rather reminds one of those picture-puzzles in one's youth, in which the object of the puzzle was to "find the monkey." However the monkey *can* be found (perhaps with a magnifying glass) crouching just on the left of the main fork of the bole of the tree.

We all know that the numerous species of domestic animals which man possesses and uses were originally evolved from wild species in the past prehistoric ages, but considering the enormous

variety of wild animals existing on this earth, it is curious to note how very few species of wild animals are habitually caught and trained by man at the present time or within historical times, for real utilitarian purposes. In fact, at the moment of writing I can only think of 7 or 8 such examples. I omit, of course, all circus and such-like performances, which cannot be classed as utilitarian in the strict sense of the word. To this meagre list the monkey must now be added, and personally, I have never heard nor read before of the monkey being used in this useful way. Circus and barrel-organ monkeys, everyone is familiar enough with. I am informed that monkeys are used for such purposes all over the Kelantan State.

On my way back to my camp I passed on the road three Malay bird-catchers whose portraits are given in photo No. 3. Their outfit consisted of bird-lime carried in small earthen pots and in hollow bamboo culms. They carried with them on bamboo perches some very beautiful little blue paroqueets which they use as decoy-birds. When engaged in their business they pour the bird-lime from the pots into the hollow culms and from these they smear the tree-branches.

This bird-lime is made up of various sticky gums tapped from forest trees and mixed together with Dipterocarp wood-oil. I could not find out its exact composition. They catch mynahs, paroqueets and other small birds and then sell them as cage-birds.

D. BOURKE, I.F.S.

THE CULTIVATION OF CONIFERS IN NORTHERN INDIA.

(*Continued from Indian Forester, Vol. L, pp.* 616–621.)

CUPRESSUS.—A genus of about 14—16 species divided into two sections *Eucupressus* and *Chamæcyparis*. In cultivation the members of the section *Eucupressus* grow well in Dehra Dun and even in Lahore, although most of them are found at considerable elevations in the mountains. Although *Cupressus* roots fairly readily from cuttings they are so easily grown from seed that propagation by cuttings is unnecessary. They are so variable

that the species are difficult to recognise and no two authorities agree as to the number of species in the genus.

The members of the section *Eucupressus* are as follows:—

C. arizonica, Greene.—Introduced in Lahore and Saharanpur about 1912 from seed procured in Europe. A plant of about this time in Dehra Dun has just started to produce cones. Our plants are from seed collected in South Africa and have reached a height of 4—6 feet in three years from seed and are growing vigorously. This species is glaucous and ornamental, but is apt to fall over after heavy rain and requires attention to see that it keeps erect. Only the form var. *bonita*, Lemm. or *C. glabra* Sudw., is in cultivation.

C. Benthamii, Endl.—This tree has long been introduced and there are some large specimens in Dehra Dun. It resembles *C. torulosa* very closely but has less pendulous branchlets and has much more pointed bosses on the cone-scales. It is often considered a variety of *C. lusitanica.*

C. cashmeriana, Royle ex Carr.—A plant of very doubtful status. It is only known in cultivation. It is not grown in India as far as is known.

C. Duclouxiana, Hickel.—The Yunnan representative of *C. sempervirens.*—Not known to be cultivated in India.

C. funebris, Endl.—Has long been introduced but does not thrive as well as some of the other species and does not reach any great size. It is common in gardens but after reaching about 30 feet in height by 3 feet in girth it is usually past its best. It will grow in Calcutta.

C. Goveniana, Gordon.—I know of no old specimens in Northern India. We have seedlings one year old which are doing well.

C. lusitanica, Mill.—This tree is very rarely cultivated in the plains but is frequently seen in hill stations. It resembles *C. torulosa* but has wide-spreading branches and prominently pointed cone-scales. We have seedlings one year old.

C. Macnabiana, Murray.—Not in cultivation as far as is known.

C. macrocarpa, Hartweg.—This species is supposed to be in cultivation in Dehra Dun and Saharanpur, but the specimens are doubtfully true to name. It is grown in Abbottabad and probably in other hill stations.

C. sempervirens, Linn.—The fastigiate variety var. *indica* Parl., is a very old introduction to India. It was introduced to the Botanic Gardens, Calcutta, before 1794 and was probably cultivated in all the old Moghul gardens. Of recent years there has been a tendency to replace it by var. *stricta*, Aiton, a similar form cultivated in Europe. This latter form tends to be ragged and is altogether inferior to var. *indica* for formal planting. The wild form var. *horizontalis*, Gord., is also occasionally seen both in the plains and in hill stations.

C. sempervirens var. *indica* seeds freely in Dehra Dun and the seeds are quite fertile. I have heard complaints that this form does not produce fertile seed in India and this has probably lead to seed of var. *stricta* being imported in place of it.

C. torulosa, D. Don.—Was cultivated in Calcutta in 1842 and is still grown. It is not often seen in the plains of northern India but grows fairly well. It thrives in Dehra Dun where there are many specimens varying considerably in habit but they can scarcely be placed into the varieties recognised in Europe.

The members of the section *Chamæcyparis* are mostly unsuitable for the plains. They are—

C. formosensis, Henry.—Has been sown in Dehra Dun but failed to germinate.

C. Lawsoniana, Murray.—Cultivated in Darjeeling.

C. nootkatensis, Don.—Not known to be in cultivation.

C. obtusa, Koch.—Not known to be in cultivation but should do well in the Himalaya.

C. pisifera, Koch.—Is growing fairly well at Annandale, Simla.

C. thyoides, Linn.—Was in cultivation in Calcutta in 1842 and according to Voigt had been grown for many years without flowering. It is the only member of this section likely to grow at low elevations but should be given a wet situation.

The "Cedar of Goa".—The idea which has been prevalent in Europe since 1687 (Hermann, Hort. Lugd. Bat. Cat., p. 346, Juniperus ex Goa) that *Cupressus lusitanica* was introduced by the Portuguese from Goa has led to this tree receiving a quite unmerited mention in many Indian Floras. That the tree is a native of India has been stated over and over again, this statement being based only on its vernacular name. Masters in Journ. Linn. Soc., Vol. XXXI, p. 331, state that the tree is not wild in the neighbourhood of Goa, and there is no doubt whatever that it is not a tree of India proper. The only possibility of the tree being Asiatic would be to suppose that it is a cultivated form of the Himalayan *C. torulosa* but this is highly improbable as is also the suggestion that it came from China. The difficulties in connection with the tree being indigenous to India caused a shifting of position, and the statement has been made by Hooker in the Flora of British India that *C. lusitanica* "is extensively cultivated in the Western Ghauts and thence introduced into Portugal." This statement seems to be based on Dalzell and Brandis, and is much more emphatic than either. Brandis, For. Flora, p. 534, quotes Dalzell and if we turn to his Bombay Flora, Suppl., p. 83, we find under *C. lusitanica* "now common in gardens, Native and European. It does not succeed below the Ghauts and above only where the soil is rich and deep. When the tap root touches the rock below, the tree begins to die. Those planted at Koregaum and Phoolshuhr have long ago assumed an appearance denoting speedy extinction. Of those at Dapoorie one or two of the largest die off every year. The healthiest appear to be those in front of Sir Jamsetjee's bungalow in Poona but they are yet young and have their trials to go through." Following this is *C. torulosa* under which is stated "It appears to succeed better in the Deccan than the Mediterranean tree; casualties have been fewer." From this I conclude that *C. lusitanica* had in 1861 been recently imported from Europe and that a number of plants had been planted in gardens in Poona and a few other places. Dalzell and Gibson wrote their supplement mainly for the public and other gardens in or near Poona and Bombay. I do not think Hooker was justified in

stating that the tree was extensively cultivated merely on the statement of Dalzell and Gibson "now common in gardens, native and European."

The earliest reference to the Cedar of Goa in Indian Botanical Works seems to be Royle, Ill. Bot. Himal., p. 349, 1839. "The species of Coniferæ found within the limits of the Indian Flora are first *Cupressus sempervirens* called *suroo;* the Goa Cedar *Cupressus pendula* and *Thuya orientalis,* which succeed in the gardens of the North as of the South of India." Graham's Catalogue of plants grown in Bombay was also published in 1839 and he appears to have mentioned only one *Cupressus*, viz., *C. glauca*, Lamk., as grown in gardens in Bombay and the Deccan. Royle by *Cupressus pendula* doubtless intended *C. funebris* and his identification of this species as this Cedar of Goa seems to be based on the grounds that in his day, as now, it is one of the three most widely cultivated conifers. Graham may have also meant *C. funebris* but thinking it the Cedar of Goa called it *C. glauca.* This, however, is mere speculation and impossible to prove in the absence of specimens of Graham's "Cedar of Goa."

There is no evidence that *C. lusitanica* is widely cultivated in Western India and a good deal to show that it is not. Cooke and Woodrow both mention it as one of the introduced species, but neither states that it is commonly cultivated. Cameron in his Edition 5 of Firminger's Manual of Gardening mentions *C. sempervirens* and *funebris* as being the most frequent species in gardens in S. India and states that *C. torulosa* is not uncommon. *C. lusitanica* is mentioned as one of the "other species found in cultivation, mostly in Botanical Gardens."

Balfour, Timber Trees of India and of Eastern and Southern Asia, ed. 3, p. 87-88 (ed. 1 appeared in 1858) quoting from O'Shanghnessy, The Bengal Pharmacopœa, 1844, p. 621, mentions that "*C. pendula* ? is the drooping cypress or Goa Cedar of the South of Europe." This can scarcely be anything but *C. funebris* as *C. lusitanica* is separately mentioned as the "Cedar of Goa." Again quoting from Riddell, a Manual of Gardening

for Western and Southern India, ed. 3, 1856 (I do not know when ed. 1 was published) he says under *C. glauca.* "This is a tall elegant and graceful tree well adapted for border walks in a garden being always green and a favourite with the natives of India. It grows easily and is generally planted alternately with *Areca.*" This can hardly be any species of *Cupressus* and seems to refer to *Casuarina equisetifolia.* The vernacular name he gives is *Saras* which is the name of *C. sempervirens*, but it is not unlikely that it is also used for *Casuarina.* Gamble gives *Serva* as the Telegu name and Talbot gives *Sura* as the vernacular name of *Casuarina equisetifolia.* If there has been confusions between *Casuarina* and the Cedar of Goa as seems probable the statement regarding its cultivation in Western India would be fully explained. So many of the authors quoted have copied from other sources, that it is impossible to say how much of what they have written is based on their own observations.

THUYA.—A genus of seven species, of which 5 belong to the section *Euthuya* and one each to *Thujopsis* and *Biota.* I have seen none of the section *Euthuya* in cultivation and they are not promising for the plains. *T. occidentalis*, Linn., was tried in Calcutta in 1809 and lived up to 1814 without flowering. Though mentioned by Voigt it was apparently not living in 1842. It is probable that other species are in cultivation in hill stations but I have not observed any. *Thuya dolobrata*, Linn., more often called *Thujopsis dolobrata*, Sieb. and Zucc, is growing well at Annandale, Simla. The only member of the section *Biota—Thuya orientalis*, Linn., is the commonest conifer in gardens in Upper India. It is probably a very old introduction being grown in Calcutta before 1794. We have specimens of it from Hoshiarpur, Hyderabad, Sind, Jubbulpore, Sukna, etc., so it is widely distributed in gardens. It is also grown in hill stations such as Simla and Naini Tal. It is very variable in cultivation being sometimes a small tree 20—30 ft. high and at other times a large shrub with many stems from the base 8—10 ft. high and rather more across. It is easily grown from seed.

JUNIPERUS.—A genus of 30–40 species of trees and shrubs. In cultivation this is perhaps the most difficult genus of the

family. The species are mostly variable, many of them are diœcious so that as a rule only one sex is found in any one garden. The result is that in most gardens, where many conifers are grown there are several unidentified junipers. A satisfactory monograph of the genus clearing up the confusion in the wild species would be of much help in identifying the cultivated forms. Roxburgh in the Hortus Bengalensis mentions 6 "junipers" and he shortly describes 7 in his Flora Indica. Some of these are not junipers at all as the genus is now understood and those that are junipers are probably mostly forms of *J. chinensis*, Linn.

J. chinensis, Linn., is not uncommon in gardens and is grown in several forms. It was probably introduced in 1812 to the Botanic Gardens, Calcutta, and of the form commonly cultivated in India only the male plant seems to be grown. It is propagated by cuttings and does fairly well in the plains. There are some old specimens in Dehra Dun.

J. procumbens, Sieb.—This seems to be an old introduction possibly dating from Roxburgh's time. It is often seen in gardens and grows well but does not flower.

J. recurva, Buch. Ham.—This is listed for Calcutta in 1913 and is, I believe, correctly named. The tree does not flower in Calcutta or in Lahore but grows fairly well and is ornamental.

Voigt mentions *J. barbadensis*, Linn., and *J. bermudiana*, Linn., as growing in Calcutta in 1842 and though cultivated for many years states that they had not flowered. He also mentions *J. Sabina*, Linn., as having been tried. Duthie in his Flora of the Upper Gangetic Plain mentions *J. macropoda*, Boiss., as thriving in Saharanpur but I suspect the tree referred to is *J. chinensis*, Linn.

I have seen *Juniperus rigida*, Sieb. and Zucc., growing well in Abbottabad and *J. virginiana*, Linn., doing well in Kumaon at 5—6,000 ft.

We have young plants of *J. bermudiana*, Linn., *J. virginiana*, Linn., and *J. procera*, Hochst., all doing well especially the last. Probably half the species in the genus could be grown in Dehra Dun as they are not very particular as to climate. I have found

imported seed germinate fairly well but it is apt to take some time owing to the hard bony seeds. They may be propagated by cuttings but the species with scale-leaves are said to be more difficult to root than those with needle-leaves.

(To be continued.)

R. N. PARKER, I.F.S.

To say that we have got our forests for nothing, and that everything we get out of them, therefore, less the cost of felling, extraction and sale is net profit to us, is neither sound forestry nor national economy. Before we fell, it is incumbent on us to see that there exists on the ground sufficient regeneration which in due course will give unto posterity the equivalent of what we fell. Or, we should immediately after felling, raise artificially the required young crop and establish it by proper tending. If we regenerate artificially we must remember that we cannot go against nature by endeavouring to grow what won't grow in a particular place, or by growing what will grow there, without care or method. We must have, therefore, studied the question and formed definite ideas as to what species to regenerate with artificially and how to do it, before we start felling. This fundamental factor, in any forestry worth the name, I find side-tracked in the commercial audits carried out recently in some of these districts.

It is wrong to treat State Forest industry exactly on a par with commercial concerns. It should be considered as a trust which we have taken upon ourselves to administer for the nation or as a patrimony we are solemnly charged to pass on to those who come after us, improved or at any rate undepleted. In administering it, it would be a great help, no doubt, to know its money value; and is it not impossible to assess a money value on our forest property more or less accurately. But I venture to think that it is immaterial to the ultimate object we have in view. Having taken the forests over as a going concern, our capital is our stock in trade,—the growing stock. Every time we sell, we must replace and then see what is left over. Very simple! and yet to convince our carping critics some sort of kaleidoscopic accounting, hall-marked with the title "Commercial" appears necessary. It must not, obviously eclipse the vital point of Regeneration, but should exhibit it in the most vivid colours.

The Accountant, commercial or non-commercial, should always bear in mind that unlike ordinary mercantile enterprises it is not possible in forestry to separate capital and profits. Every tree that is cut represents part of the capital, interest and

THE COMMERCIAL EXPLOITATION OF INDIAN FORESTS.

"Commercial Exploitation" of Forests and "Commercial Accounting" are matters which are at present engaging the serious attention of Forest Officers. Before venturing on new schemes, it is necessary that we understand ourselves and have definite clear cut ideas of what we really want. Is it the maintenance and improvement of the Forest Estate, making it at the same time economically (not necessarily financially) worth the while of the nation, now and for ever, that we want? Or is it mere "exploitation" in the baser sense of the term that we have in view? In other words, is the idea to work the forests in accordance with the accepted principles of sylviculture and national forestry? Or is it merely to make a profit by cutting them down? If the former there is nothing new in it, but it is the same old idea which, I believe, we have been endeavouring all these years to carry out. I am afraid, however, that some of us have been caught in the glamour of catch phrases and our vision has been dazzled by the silvery implications of the magic words.

Forests constitute the living wealth of a nation but are liable to decay and death, or improvement. They are not to be worked, therefore, as mines, which may be classed as dead wealth. These are platitudes, perhaps. But sometimes platitudes cannot be too often repeated or over-emphasised. The Americans worked their forests like mines in the past. They took "the cash in hand and waived the rest," and now they are bemoaning their folly, and getting anxious about their future timber supplies

To say that we have got our forests for nothing, and that everything we get out of them, therefore, less the cost of felling, extraction and sale is net profit to us, is neither sound forestry nor national economy. Before we fell, it is incumbent on us to see that there exists on the ground sufficient regeneration which in due course will give unto posterity the equivalent of what we fell. Or, we should immediately after felling, raise artificially the required young crop and establish it by proper tending. If we regenerate artificially we must remember that we cannot go against nature by endeavouring to grow what won't grow in a particular place, or by growing what will grow there, without care or method. We must have, therefore, studied the question and formed definite ideas as to what species to regenerate with artificially and how to do it, before we start felling. This fundamental factor, in any forestry worth the name, I find side-tracked in the commercial audits carried out recently in some of these districts.

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The Accountant, commercial or non-commercial, should always bear in mind that unlike ordinary mercantile enterprises it is not possible in forestry to separate capital and profits. Every tree that is cut represents part of the capital, interest and

profits. And as forest capital can be assessed only in growing stock, every tree that is cut must be replaced by sufficient regeneration to yield its equivalent in course of time, before we ever think of calculating our profits. Else, we shall be paying dividend out of capital.

Having cut and sold our timber, we must deduct from the receipts obtained thereby not only (1) the cost of cutting and extraction (production account), (2) the cost of transport and sale (sale account), (3) proportionate cost of establishment and (4) interest and depreciation on capital works, but also (5) *the cost of regeneration.* Only the balance, if any, left over is our profit. (In the matter of capital expenditure, by the way, such as roads, buildings, machinery, etc., we cannot be over careful to see that they are not of such a magnitude as the supplies available would be inadequate to repay in due course.) The last item, *viz.*, Regeneration, does not find a place in the balance sheets prepared by the commercial auditors. They have thus included their capital in their profits. In a joint stock company this is tantamount to paying dividend out of capital. It is true that we do undertake regeneration operations and spend large sums of money on them. But that is not by itself sufficient. These operations and their cost must find a place in the balance sheet itself. They should not be treated as separate investments. No company pays its shareholders part of their shares with the dividends, and collects it back again and starts a fresh share account. Regeneration is strictly incidental to forest exploitation and its cost must find a place in the Exploitation Account. We should be just neither to ourselves nor to the public, if we separate the two.

Stock taking and valuation of stock is a part of all commercial audits. But there is no mention of stock in forest audits; I mean the growing stock, which is our stock in trade. I wish the commercial auditors were also trained Foresters so that they could certify that not only is everything right on paper, but also on the ground,—not only is expenditure shown on regeneration but also that regeneration is adequate and truly represents the capital removed.

In the case of forests like those of Nilambur, conditions are slightly different in that the Government have paid for the land, the plantation and some other areas having been leased, and a big block of natural forests bought outright. The plantation areas when they came to the Government contained valuable natural forests which were cut and sold and the ground restocked with teak. In the beginning the expenditure side of the business exceeded the revenue side, but after some years matters were reversed. From that time we ought to have set off from the surplus revenue, interest on, and part of, the capital invested on the land and in planting. Having worked off the capital like this, we should have brought the estate on a par with other Forest Estates, that is, as a going concern.

In other words, the money originally invested by the Government need be considered only as a state-aid to a tottering industry to be withdrawn with interest as soon as the industry is firmly set on its feet again. After that stage is reached no distinction need be made between these forests and the other state forests as regards management and accounting. When once the thing pays itself and leaves a surplus after paying for replacing what is removed, I see no point in carrying the capital forward any more in the orthodox way.

P. GOVINDA MENON, E.A.C.F.,
Nilambur.

ARTIFICIAL MONSOONS.

The Seasoning Section of the Forest Research Institute has found a new sphere of usefulness in producing "Seasons" or weather conditions, as well as "Seasoning" and drying timber.

Do you want to know what will happen to a piece of joinery in Delhi during the annual weather changes? Will it shrink and crack during the hot weather? Will it swell and warp during the rains? What will timber in a railway carriage do if run from Dehra in the cold weather and then left out in the sun in Bombay?

Or perhaps a fungus is depreciating an otherwise perfectly good timber in the Andamans or elsewhere and you want to see it happen and note just the conditions that cause the trouble and then try until you get an atmospheric state which does not encourage the depreciation.

These varying conditions can all be reproduced within four walls, regardless of what is happening outside, and changed at will either slowly or rapidly.

As an example: Three different constructional methods were proposed for some large panelling. These would be made up during the cold weather and eventually erected in the Delhi Council Chamber. The question is what will happen to these next summer, then during the rains and the next hot weather? and anyhow which is the best construction? To settle the point in the ordinary course of nature would take two years.

Three sample panels were built up according to different designs and put in a compartment in which air was circulating and then the temperature was raised to 120°F. and the humidity adjusted to 20%. After twenty-four hours of this hot and dry weather the controls were altered and a July climate turned on—100°F. with 80% humidity. Then again the climate changed to the hot dry weather conditions of Central India.

At the end of this drastic treatment the material was examined and whilst one 5-foot panel had suffered badly another was in fair condition and the third was in good order. It follows that the best way of making these panels was discovered inside a week. And this on three panels instead of perhaps wasting time and labour on making much expensive joinery which would go wrong after having been put in place for a year or more.

Even thoroughly seasoned timber, used in a climate where there are big seasonal variations, will always contract during the dry weather, and expand during the rains. Varnish, polish or wax reduces but does not eliminate this difficulty. The designer must allow for this, but to do so, it is required to know the extent of the movement which takes place in the timber and this can be done by subjecting boards of various species to these alternating conditions.

In these hurried climatic changes, time is shortened and to compensate, temperature or humidity is exaggerated, and to make these results not merely comparative but absolute the results are corrected by comparison with timber that has been exposed to atmospheric changes over periods of years and measured continually as to expansion and shrinkage.

The relative resistance of various species of timber to exposure to heat, can be found in a similar manner using some wood of known value as standard of perfection. The classification obtained in a brief time will save expensive mistakes when trying the many Indian timbers, and will help to put each in its most useful place.

It is evident from what has been said above that we have still much to learn as not only do the climatic conditions vary from province to province but the number of useful species found in the forests of India is very large while we are only at the very beginning of our experimental work.

STANLEY FITZGERALD.

THE LATEST NEWS ABOUT SOME INDIAN TREES.

The following extract from a recent foreign government publication may amuse readers of the *Indian Forester*:—

"While Mr. P*p*n* was carrying out a difficult piece of exploration work in Ecuador, J*s*ph F.R*ck, our newly appointed agricultural explorer was searching for the source of chaulmoogra oil in Siam and Burma. This oil or rather the ethyl esters of its constituent chaulmoogric acid, which was originally discovered and described by Dr. Frederick B. Power, has come into great prominence as a cure for leprosy through the researches of Dr. Dean and his collaborators in Honolulu. The source of the oil, which comes into commerce through Burma, was quite obscure when Mr. R*ck first took up the study of these trees, and was commissioned as an agricultural explorer to investigate the whole subject; no photographs had ever been made of them. He spent several months in the jungles of Siam

and Burma and went through experiences quite as thrilling and dangerous as any to which explorers in tropical countries are liable, including a unique one with a man-eating tiger......Not only has he in large measure solved the problem of the source of chaulmoogra oil but he obtained seeds of the true chaulmoogra tree......as well as the false chaulmoogra tree (*Gynocardia odorata*) which for years was erroneously supposed to be the source of chaulmoogra oil."

We are sorry to have to inform Mr. R*ck that his claim comes only a quarter of a century too late. We notice that his tour included a visit to Darjeeling. Did he expect to find chaulmoogra there or was he trying to discover a view? A cheaper way of "discovering" quite a lot about chaulmoogra would be to invest a few dollars in literature. The Agricultural Ledger, No. 5 of 1905, for example, would cost only 4 cents plus postage (at normal rates of exchange and rather less as long as the dollar remains at its present inflated value). We admit that it is somewhat dull and contains no thrills from man-eating tigers. There is no view from Darjeeling in it either, but it does have some quite nice pictures showing seeds of *Taraktogenos Kurzii* under the name true chaulmoogra oil, and seeds of *Gynocardia odorata* which is stated to be the origin of the false chaulmoogra oil.

The man to make the discovery that *Gynocardia odorata* is not the source of chaulmoogra oil of commerce was a French pharmacist, M. G. Desprez, and the date 1899. The following year Sir D. Prain found that the seeds that give the true chaulmoogra oil actually come from *Taraktogenos Kurzii.*

Another statement from the same foreign source (and not as one might suppose from a student's examination paper in answer to the question "What do you know about *Dendrocalamus strictus?*") is as follows :—*Dendrocalamus strictus*—A bamboo native to India and extending to Burma, which grows on dryer ground than bamboos generally. It attains a height of 100 feet and its strength and solidity render it fit for many select technical purposes. This bamboo endures great cold as well as dry heat and is useful for consolidation of embankments on account

of its network of fibrous roots. It occasionally forms forests of its own, seeds almost annually, which is exceptional amongst the *Bambusaceæ*, and is readily grown from seed......"The writer of this should be given the credit of knowing that *Dendrocalamus strictus* is a bamboo and not a palm or bark-beetle or something of that sort.

R. N. P.

COMMERCIALISATION OF GOVERNMENT CONCERNS.

Two important companies have been formed to take over from the United Provinces Government the Government turpentine and rosin factory and the Government sawmill and turnery at Clutterbuckganj, near Bareilly,—the Indian Turpentine and Rosin Company, Limited, and the Indian Bobbin Company, Limited, with offices in the civil lines at Cawnpore. In the case of the former, 50,000 shares of Rs. 10 are offered to the public, the Government retaining 60,000 shares, while in the case of the Bobbin *Company, 45,000 shares are offered, Government holding a similar* number of shares. Besides, Government also holds debentures of the value, approximately of Rs. 6 lakhs, in the two companies. The Boards of Directors consist of Mr. H. G. Billson, Chief Conservator of Forests, Mr. C. T. Allen, C.I.E., Mr. T Gavin Jones, M.L.C., and Mr. J. P. Srivastava. The business acquired by the Companies includes a concession in the shape of first option on and guarantee for the supply of crude rosin from the Kumaon forests and timber from the Government forests for the manufacture of bobbins and other turnery articles. In connection with the Bobbin Company, additional machinery, costing about Rs. 3 lakhs, was ordered from England and has now been erected in order to increase the outturn of bobbin. With this end in view the services of a European expert have been requisitioned as manager. The outturn capacity of the company's plant inclusive of the additional machinery recently installed, is estimated to be worth, approximately, Rs. 11 lakhs per annum in bobbins alone, exclusive of the outturn value of other turnery articles. There is a wide scope for the absorption of the company's products, especially in view of the 15 per

cent. duty imposed on imported bobbins, and it is stated that extensive orders have already been received. In the case of the Turpentine and Rosin Company, the industry is already a well-established one. There is only one other factory in India, and the monopoly of the entire Indian market in turpentine and rosin is held by these two factories. According to Government reports the United Provinces Forest Department has made a profit of about Rs. 20 lakhs during the seven years ended 31st March 1922, which period includes one year in which, owing to extensive fires in the Kumaon forests, the factory had to remain practically closed for want of raw material. The terms of transfer from the possession of Government are very favourable, and the companies are starting under very good auspices.

THE MAKILING ECHO.

We have received Nos. 1—3 of Vol. III of the *Makiling Echo*, a journal issued quarterly by the Division of Investigation, Bureau of Forestry, Philippine Islands, at Los Banos College, Laguna. It displays many points of interest and originality not the least of which is the fact that it dispenses with the printing press; the original typescript is hectographed and the sheets are tied together with the bast of *Abroma fastuosa* (Sterculiaceæ).

Among the technical articles are contributions on the relative durability of Philippine woods, fishponds in swamps, the manufacture of charcoal by the Japanese process, rafting and loading timber in Palawan and an account of a fungus, *Schizophyllum alneum*, considered to be the cause of death of many trees in Southern Luzon. The last article is illustrated by actual specimens of the sporophores gummed to the paper.

The college student is catered for more particularly by lectures on geology and soils in relation to forestry, the grammatical use of English, etc., and by Notes on the activities of present and past students.

THE MADRAS FOREST COLLEGE MAGAGINE.

We regret to learn that the committee of management of the Journal of Coimbatore College has decided to publish only two issues a year in future, and is contemplating the suspension of its magazine, if there is no improvement in the contribution of articles from outside. The present number, Vol. IX, No. 1, contains the winning essay for the *Indian Forester* prize for 1924, by K. P. Rajalingam on the Regulation of Grazing in Forests, and also articles on the forest village system in the Javadi Hills of the N. Arcot District, and on a fight between wild dogs and a sounder of wild pigs; and accounts of the prize-giving and athletic sports.

REVIEWS.

RECENT DEVELOPMENTS IN LOGGING.

LOGGING, by RALPH CLEMENT BRYANT, F.E., M.A.; 2nd Edition, Revised, pp. 556, figs. 165. John Wiley and Sons, Inc., New York : Chapman and Hall, Ltd., London.—1924. Price 22*s*., 6*d*. net.

The aim of the author, as stated in the preface to the first edition, was to bring out a text-book for use in Forest Schools. In the second edition the subject matter has been brought up to date and to some extent re-arranged. The book contains a very complete account of logging practice throughout the American Continent, and therefore applies to Canada as much as to the U. S. A.

When the reviewer was sent on deputation to America in 1918, to study Western methods of logging, Bryant's book was the only one of its kind then available. Perusal of the book, and the personal advice and assistance so generously given by Professor Bryant, made all the difference to the value of the tour. Within the short space of five months it was possible to form a very comprehensive idea of logging practice everywhere.

The chapter on Tractors in the second edition is of special interest to the writer, because of the few opportunities there were in 1918 for seeing tractors at work, and the great developments that have subsequently taken place in this branch of the logging industry. It is now beyond question that tractors, especially of the caterpillar type, have a recognized position in lumbering in America. Their field of usefulness is likely to increase in the future with carefully conducted experimental work.

A number of tractors were imported into Burma about four years ago. The writer cannot say for certain what has happened to them, but he is under the impression that they have not been looked upon as a success. It would serve a very useful purpose if the subject were studied on the spot, and the results communicated to the *Indian Forester*. The writer is still convinced that there is a good field for them in logging operations in the East. The following short extracts from chapter XIII are very sound :—

> Many breakdowns could be eliminated if competent drivers only were hired, and they were financially interested in the continuous productive run of the machine,............................
>
> The relative efficiency of tractors as compared with animals depends on many factors. Other conditions being equal, the horse has advantages over the tractor in work which is no tiresome, and which only occasionally requires a short and powerful effort, whilst the opposite is true on long hauls and on continuous adverse grades. As compared to a tractor animals are handicapped where they cannot get proper footing, such as on loose ground and in swamps, and also in heavy work where several animals must be used together, since much energy is then wasted due to lack of simultaneous action..
>
> Studies of logging operations where horses and tractors work under identical conditions, indicate that the ratio between the efficiency of horses and tractors varies within wide limits, although in hauling, one horse is equivalent to 2 or 3 tractor draw-bar H. P. Th's is due to the ability of a horse to increase its pull for a very short distance and for a very brief period from 3 to 4 times its normal for continuous work, whilst the

margin between the rated draw-bar H. P. and actual maximum for tractors is comparatively insignificant. On the other hand, a tractor develops its normal power for any length of time, whilst animals, especially under adverse conditions, become fatigued, and then decrease their pull below normal in addition to utilizing part of the working time for rest. Large tractors are preferred to small ones............ However there are about as many 5-ton as 10-ton tractors used in logging and some loggers believe they are more efficient for short distances The 2-ton crawler tractors, although sometimes used in the forest, are too small for most kinds of logging work."

If allowance be made for the use of elephants instead of horses, and for the more adverse conditions in respect to climate and facilities for repairs, it should not be difficult to form an opinion as to where tractors can and where they cannot be usefully employed in a country like Burma.

Logging practice in the East is severely handicapped by the fact that most of the manual work in the forests has to be done by very unskilled labour of a very temporary character. The average wood-cutter is conservative to a degree. He does not *take kindly to new ideas and he does not appreciate the value of* co-operation. It is therefore very uphill work to try and introduce new methods and appliances however simple. Country axes are still preferred, and although the peavey is a wonderfully efficient implement of next to no cost, it has not yet come into general use either in India or Burma. What chance therefore have big and expensive machines such as skidders? Given the head of a concern keen on mechanical appliances trial may be made but the chances are that the effort will be short-lived. A private firm may be assumed to be the best judge of its own interests, but nevertheless the thought arises that it would pay to have a larger proportion of men in the logging industry in the East with a good knowledge of the best that America and Europe can teach them of improved methods of handling timber. A young assistan may start with plenty of ideas, but he soon loses his enthusiasm from lack of encouragement from above.

The book is divided into four parts and covers 556 pages. Part I contains a very condensed summary of the book, and had better be read *last by the student outside America*. Part II deals with felling and logging proper. The two chapters on labour and camps may not be of much interest to readers in the East, but the two chapters on tools and conversion into logs are well worth careful study. Part III deals with transport by land. In the introductory chapter (page 123) the subject is discussed under two heads, *viz*., Secondary, or short distance, and Primary or long distance transport. The choice of terms is rather confusing. As short hauling from stump generally comes first, it would have been preferable to have called it the primary operation. Part IV deals with transport by water. The description of Ocean Rafting (page 427) is worth serious consideration by the Government of Burma, as was pointed out by the writer in 1919. There is money in the idea of towing rafts of teak logs across the Bay of Bengal for conversion in India.

The writer has nothing but praise for the book as a whole. An attempt is made to describe the various methods of transport in their logical sequence. Operators in the East, both large and small, might do worse than study the book in detail, that is if they are prepared to admit the possibility of improvement in their *methods of logging*.

But when all is said and done, we come back to the inherent conservatism of the East. The recent change in the form of Government in India and Burma has retarded developments in the timber trade rather than otherwise. No big scheme of departmental extraction appears to stand the slightest chance of being undertaken. The tendency is all to leave everything to private enterprise, a policy which, in Burma, means leaving it all to a small number of big monopolists. Profits from teak are so great and certain that most firms in the trade decline to touch other timbers, and so the trade in them is slow in development. There are two exceptions and the firms concerned deserve every encouragement.

F. A. LEETE.

EXTRACTS.

THE MANUFACTURE OF CUTCH IN NORTHERN SIAM.

Cutch or *Sisiat*, an extract from the heartwood of a small to medium-sized tree (*Acacia Catechu*, Willd., var. *catechuoides*, Prain), locally known as *Mai Sisiat*, is manufactured throughout Northern Siam. This industry is probably of ancient date; in the neighbouring country of Burma it was well established in the sixteenth century; even then Pegu cutch was being exported; no doubt it was also being manufactured in Siam at that time. It is interesting to note that the first cutch to reach Europe went by way of Japan and, as it was considered to be a kind of earth, was named *Terra Japonica*. Gambier, the product of quite another plant, reached Europe about the same time and was called *Terra Japonica* indiscriminately with cutch, and hence arose a confusion between the two substances which lasted many years.

Some of the cutch manufactured in Northern Siam is exported to Bangkok; that consumed locally is used almost entirely for chewing with betel; recently, however, the Siam Industries Company have been using it for dyeing and tanning leather.

The cutch tree is found in all the provinces of Northern Siam but Chiengmai produces the most cutch as the tree is more plentiful there. In some districts, more particularly in the Nan neighbourhood, the tree is planted; elsewhere most of the cutch is obtained from wild trees.

Several kinds of cutch are on the market, the three chief varieties being:—

1. *Sisiat deng*.
2. *Sisiat dam*.
3. *Sisiat poi*.

Varieties one and two differ in colour, the first being the darker and considered the more valuable. This difference in colour depends on the colour of the heartwood, *Sisiat dam* being the product of trees with a very dark red heartwood, while *Sisiat deng* comes from trees with a heartwood of a lighter colour. It

is said that the trees with the darker heartwood usually have the young leaves of a reddish tint, this tint not being found in trees with a lighter heartwood. However this may be, the cutch manufacturers are often unable to predict the colour of the heart-wood before felling the tree. Other differences in the trees are noted, thus those with numerous thorns are known as male trees and those where the thorns are scanty or absent, as female trees. Such differences do not seem to be associated with any differences in the quality of the cutch produced.

The third variety of cutch, *Sisiat poi*, is of inferior quality, brittle and porous, and is obtained from the heartwood of dead trees. It is seldom made, as the cutch is more difficult to extract from such trees and the price it fetches scarcely repays the manufacturer for his labour. The cutch extracted from the heartwood of cutch-tree roots, known as *Sisiat rak*, is a less important variety ; it is very dark and rather brittle.

Cutch is manufactured almost entirely in the dry season because then there is but little other work to be done and the stages of manufacture are more easily completed in drv weather.

In the preparation of cutch the heartwood only is used, such heartwood being found in the trunk, larger branches and roots. This heartwood is cut up into very small chips, the smaller the better. These chips are put into a large iron pan, in the centre of which is a cylinder of bamboo wickerwork open at both ends. Round this cylinder the chips are packed and the pan is then filled with water until the chips are covered. The object of the cylinder is to facilitate the inspection of the watery extract resulting from the cooking process which follows and to enable the same to be bailed out without disturbing the chips. The pan is now put over a fire to simmer for some hours. When a sample of the extract taken from the cylinder in the centre is considered to be a sufficient depth of colour, all the extract is bailed out and poured into a second and similar pan. Fresh water is poured over the chips in the first pan and the contents boiled again. When the boiling is completed the extract so obtained is also transferred to the second pan. After two boilings the chips are usually considered to be exhausted and are thrown away but

occasionally they are boiled a third time. The second pan, containing the liquid extract from the chips, is now subject to a prolonged boiling, lasting for one or two days, with frequent stirrings, until the liquid becomes thick and will only just drop from a stick. This thick, syrupy extract is then set apart in the shade to dry. Usually it is placed in dishes or tins but often these are dispensed with and it is deposited in small lumps or masses on the surface of leaves. The drying process takes from five to ten days or longer, the length of time depending chiefly on the size of the masses of cutch. When dry and hard the cutch is ready for the market.

Adulterants are occasionally used, either to deepen the colour of extract or to increase its quantity. Rice-flour, fine clay and the powdered bark of *mai machok* (*Schleichera trijuga*, Willd.) are the chief adulterants for increasing the quantity. They are mixed in after the final boiling and before the cutch hardens. These substances are fairly easily detected on tasting the cutch. The barks of two trees *mai du* (*Pterocarpus macrocarpus*, Kurz) and *mai kawo* (*Butea frondosa*, Roxb.) are used for deepening the colour of the extract; when so employed, dried fragments of these barks are mixed with the *Sisiat* chips before boiling.

The price of cutch varies from year to year and also according to quality and season, being cheapest in the manufacturing season and dearest towards the end of the rains. In 1921, best quality cutch fetched Tcs. 6 to Tcs. 7 a *mûn* in the manufacturing season, rising to about Tcs. 12 in the rains. Poor qualities may only fetch half these prices.

Some years ago a sample of Chiengmai cutch was sent by the Royal Forest Department to the Forest Research Institute, India, for analysis and an opinion as to its commercial value. The results were as follows:—

ANALYSIS.

Moisture	13·77 %
Ash	5·54 „
Total soluble solid...	67·40 „
Insoluble in water at 98 C.	13·29 „
Total ...	100·00

Non-tannin	... ...	21·30 %
Tannin	... ...	46·10 „

Catechin	... ...	29·32 %
Absolute alcohol extract	... ...	82·62 „
Insoluble in alcohol	... ...	3·61 „

REPORT.

"From its composition, it is clear that the Cutch is of an average composition and will do as a dye, though it is doubtful if its deep colour will permit of its being used as a tanning agent. It should be classed as "Solid Burma Cutch," which is generally used for dyeing fishing nets in England. In India similar cutch, under the name of "Red Katha," is sold for edible purposes."

——:o:——

A good deal of research work has been done in India with the object of discovering the best and most economical methods of manufacturing cutch. Sir George Watt in "The Commercial Products of India," gives a useful summary of this work with the chief recommendations resulting therefrom, they are:—(1) That copper pans should be used for boiling the cutch; the use of iron pans is wasteful as the iron of these pans precipitates or alters a certain proportion of the active principles of the cutch. (2) That the heartwood should be reduced to shavings with a carpenter's plane before boiling; this results in a much higher yield of tannin and catchin than is the case with chips; the amount of water used with shavings can be lowered to ten times the weight of wood and the boiling can be shortened to half an hour. This reduction of the wood to shavings means not only a great saving in the time of manufacture but it also leads to the production of a superior extract.

The cutch tree yields, in addition, a gum which is a good substitute for Gum Arabic and in India this is collected and is put on the market as "Indian Gum Arabic." Durable timber and a good charcoal can also be obtained from the tree but its chief commercial value lies in its yield of cutch.

Pegu cutch, which is very similar to Siam cutch, forms over 90 % of all the cutch exported from India. The amount and value of Pegu cutch exported before the war, fluctuated considerably from year to year. In round figures the annual amount was from 50,000 to 100,000 cwts. and the value from Rs. 15 to Rs. 21, a cwt. On the whole, both the amount exported and the value have shown a downward tendency.

It is probable that the deep colour of Siam cutch demanded by the local market could be reduced for a foreign market, in which case it should find a ready sale outside this country. If however, the production of cutch is much increased, it would be necessary to make plantations of the tree as there are not sufficient wild trees to supply a larger demand than exists at present. Planting should offer no difficulties as the tree does well on dry, sandy soil, unsuitable for most other cultivations.—[*The Record.*]

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THE FIR FORESTS OF THE PIR PANJAL, KASHMIR.

The fir forests in British India have, of late, come into the lime light not so much for their intrinsic or potential importance as for the difficulty of their natural regeneration. It was in 1877 that attention was first drawn towards this question in connection with the regeneration of the Kanjatra block in Jaunsar. Ever since the question has engaged the serious attention of other foresters. Nevertheless, it can be stated without fear of exaggeration that the matter is still wrapt in mystery.

The conditions prevailing in Kulu, which are typical of those obtaining in other fir forests in British India are admirably summed up in the following words by Messrs. Parma Nand and Wright in their Note which was presented to the Punjab Forest Conference, 1922 :—

"In Kulu most of the spruce and silver fir forests are mature or over-mature. Second and third class trees are generally deficient, and reproduction for the most part is conspicuous by its absence. This was so in 1897, when the first working-plan was made and now after the lapse of a quarter of a century the composition of these forests is practically the same. Such is the case wherever these species are found."

In the same Note the authors give probable causes for the failure of regeneration but finally conclude that "whatever the cause, the fact remains, we cannot wait for natural regeneration."

Considering the general gloom which hangs over this question in British India, it will be of interest to outside foresters to

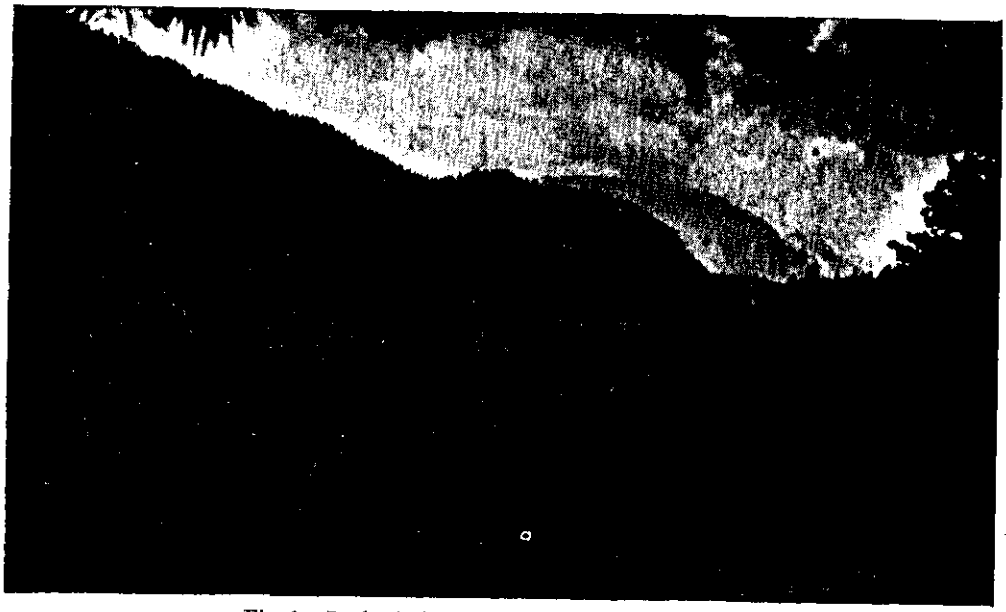


Fig. 1. In the fir forests of the Pir Panjal, Kashmir.

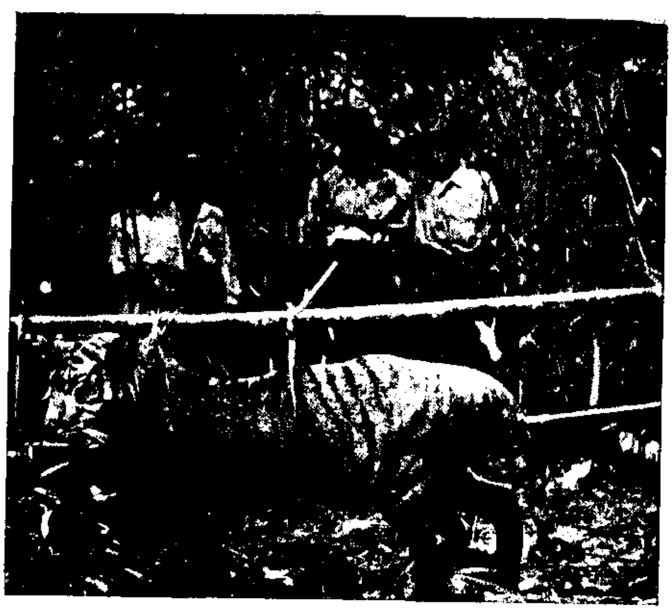


Fig. 2. A hill tiger shot in the Tharrawaddy district, Burma.

Fig. 3. Defoliation of *Gmelina arborea* in 1922 *taungya*, November 1924, Chittagong Hill Tracts

Photos No. 1 by Sher Singh, No. 2 by E.A.S.
No. 3 by M. C. Chaudhuri.

know that the Kashmir Valley appears to be singularly fortunate in this respect. Not that Kashmir is without its 'refractory' or typically bad forests, but such forests appear to be exceptional rather than the rule. There are in Kashmir miles and miles of fully regenerated forest in which regeneration has sprung up literally, 'like a weed,' and without the application of such adventitious aids as hoeing and burning of the leaf-layer. Indeed, it is most gratifying to see the way in which fir regeneration springs up spontaneously over considerable areas of the forest in Kashmir wherever the condition of overwood is favourable for such growth.

Isolated cases of this phenomenon occur all over in Kashmir, but there is, perhaps, no more typical case than that presented by the northern slopes of the Pir Panjal. This Range which forms the southern boundary of Kashmir, and which stands out like a mighty rampart between this Happy Valley and the Punjab, is covered by what are unquestionably among the most magnificent fir forests in India. From whatever standard they may be judged, quality, purity, density, maturity or reproductivity, they are far and away the finest fir forests in India. Even from a spectacular point of view, it is difficult to find a more arresting panorama than that presented by the Pir Panjal with its unending line of forests set in bold relief by a capping of eternal snow, extending from Ahrbal to Gulmarg, a distance of well over 50 miles. The greater part of this forest has never been worked, at least not thoroughly, and is now in a practically virgin condition, but there are some areas which have come rather too heavily under the axe, such as those lying in the basins of the Dudhganga and Shaliganga. And it is these latter areas which provide excellent object lessons in the different kinds of and intensities of marking. It is found that while regeneration is absent or scanty where the overwood is dark, it springs up profusely where there is a reasonable opening in the canopy. The whole of the belt which runs along the foot of the Pir Panjal from Sitaharan on the Sukhnag to Hejan on the banks of the Dudhganga, a distance of about 20 miles, is now one vast sea of regeneration, with little or no break. In many places, as near Sitaharan

the thickets are so dense that it is difficult to find their like even in *chil* or deodar. In other places, *e.g.*, Zugu Kharian, there are extensive stretches of middle-aged crop, uniform, even-aged and very much congested. While in other parts still, all age classes are well represented, such as one might find in normal selection forests in Europe.

On the other hand, the virgin forests near Hirpur in the Rambiara series, are devoid of regeneration even though the forest floor is clean. In such cases, however, it is not difficult to understand the failure of regeneration because the canopy is complete, and it is probable that regeneration will follow the lightening of overwood, as it has already done in gaps and openings.

There are some cases in which the dark overwood is accompanied by dense growth of weeds, namely, *guchh* (*Viburnum foetens*), *nera* (*Skimmia Laureola*), *gandelu* (*Sambucus Ebulus*) and *pohu* (*Parrotia Jacquemontana*). In these wet forests, the regeneration of fir will be probably attended with considerable difficulty, but there is no reason why regeneration operations which have been found so successful in deodar forests in Kulu should not prove equally effective in Kashmir.

Barring these isolated cases, however, one is led to the conclusion that the fir forests of the Pir Panjal appear to be exceptional in that they are far more susceptible of regeneration.

This, however, is by no means the only peculiarity which distinguishes these forests from those in British India. Take, for instance, the proportion of spruce to fir. In British India, spruce may occur pure, but is very often an associate of silver fir. In the latter case, the proportion of the former to latter may be as high as half and half. In Kashmir, however, spruce is scarce; it occurs sporadically in the fir forest, but, on the whole, its proportion seldom exceeds 3—5 per cent. Occasionally the proportion goes up to 10—15, per cent, *e.g.*, in the Surakhnari forests near Hejan, but this is an exception rather than the rule. And even when spruce is mixed with fir, it tries to seek spurs, ridges or edges of the forest. This is just as it should be because spruce requires more light

than silver fir. For the same reason, regeneration of spruce in a fir forest is either absent or markedly deficient.

As against this, it must be noted that spruce occurs in company of *kail*, and it is in these forests that its proportion is fairly high, and it flourishes and reproduces itself with great freedom and abundance. This, for instance, is the case in the Naujan forests near Mithwoin, opposite Hirpur. Further, mixed thickets of *kail* and spruce regeneration very often spring up in Kashmir in shingle islands in the beds of rivers, very much like *khair* and *shisham* in India.

For some time past, it has been generally realised that spruce is more akin to *kail* than to silver fir. The Naujan forests appear to afford a more or less conclusive proof of this affinity. For the right-hand bank of the Rambiara is full of fir, whereas the opposite bank is covered with *kail*. Spruce, in this case, has evidently a choice between this or that bank of the river. And it had unmistakably parted company with fir and positively declared itself for *kail*.

The typical associate, therefore, of silver fir in Kashmir is not spruce, but it is either *kail* (Shopyan) or *kail* and deodar (Lolab), though even in these cases the tendency is to seek out different elevations of aspects.

Still another peculiarity which must be mentioned is the remarkable purity of the fir forests in Kashmir. In British India, the firs are very often associated with oaks, laurels, rhododendrons and a host of other miscellaneous broad-leaved species. Curiously enough, there are no oaks, laurels or rhododendrons in the Kashmir proper, no *Pieris*, *Cornus* or *Ilex*, and little or no *Euonymus*, *Carpinus* or *Alnus*. The dwarf rhododendrons occur as near Gulmarg but even these are absent over a considerable part of the Pir Panjal. The only important broad-leaved species which do occur are the birdcherry, hazel, birch, horse-chestnut and the high-level maple, but even these are very often segregated either to wet depressions or the uppermost limit of tree growth so that the forest itself remains remarkably pure.

Allied to the above is the cognate phenomenon of marked absence of weeds. *Strobilanthes*, for instance, which is such a

pest in some of the fir forests in British India, is for the most part conspicuous by its absence. The same is true of other weeds, *e.g.*, hill bamboos, brambles, *Daphne*, *Sarcococca*, etc. There are no climbers except some stray ivy. The only important local weeds have been already mentioned, *viz.*, *guckh*, *gandelu*, *pohu* and *nera*. Of these, *gandelu* (*Sambucus Ebulus*) and its occasional companions, namely, *Polygonum* spp. and *mogol* (*Senecio chrysanthemoides*) are characteristic of over-grazed areas. *Nera* is generally found on higher elevations *Guchh* is more common and is by far the worst local weed, but the growth of these weeds is limited and it can be stated that, on the whole, weed growth is much less than is usual in these forests in British India.

Lastly, it must be mentioned that in certain places, the fir forests in Kashmir descend to very low elevations sometimes to as much as 6,500′, as near Gratnar in the Lolab.

Differences such as these are by no means ordinary ; they appear to be vital and extraordinary and an attempt to explain them will be made in a subsequent article.

SHER SINGH, A. C. F.,
Kashmir.

The Chindwin rises in unadministered tracts and flows through country where the forest often comes down to its banks from more than twenty miles inland uninterrupted by village or permanent habitation. Down through the cataracts above Tamanthi whence snowcapped Saramati can be seen, past Kalewa with its wild mountain approaches to the Chin Hills of which the summits appear as a series of ledges clear cut against the sky like the teeth of a saw, it winds its way out to the more open spaces before joining the Irrawaddy near Pakokku. The hilliest country is on the right bank where beyond the fertile Kabaw valley the line of the Naga and Chin Hills divides Assam and Manipur from Burma. On this bank are immense blocks of forest 1,000 square miles or more in unbroken sequence containing bison, bear and tiger, sambhur, *gyi* and pig. The hoolock or

tailless gibbon adds his unearthly human-like cry to the chattering and whooping of monkeys of the commoner kinds. The left bank is comparatively flat with considerable forest tracts where *saing* (*Bos sondaicus*), inhabitants for the most part of more accessible and open forests, out-number bison, which delight in hilly almost mountainous country with impenetrable depths and thick cover.

Although bison are particularly numerous and give good heads, they are difficult to come up to in such country, but good fortune took me in the hot weather of 1922 to the Uyu country seven or eight days' river journey above Pakokku. Five miles from the river I pitched my camp in a hastily constructed hut of bamboos, grass and leaves. The same evening at 5 P.M. on the 18th April I came up with a herd of bison. The country above the mouth of the Uyu consists of fairly low forest, and in this particular place and for miles round is level *savannah* grass and stunted *bambwe* (*Careya arborea*) with islets of high forest. The grass had been burnt and was freshly sprouting under the influence of the 'mango' showers, green and tender, such as no bison could resist. The herd stood out sharply in the evening light 16 or 17 in number with calves. I saw two magnificent bulls among the number. So open was the country that I despaired of coming closer, so resting my arm against a small tree took careful aim at about 100 yards at the biggest bull and brought him sprawling down, a second shot rolled him over. The animals were arranged in a sort of procession and broadside on, a most extraordinary thing to happen. When I arrived at the spot, I found by the fallen bull a very young bison calf of the colour of and somewhat bigger than a barking deer, left behind by the herd. The big fellow in his crash had somehow separated the calf from its mother and there it was bewildered and frightened. We shooed him off and no doubt he rejoined the herd, as he ran off in their direction.

The head is a fine one nowhere near a record, but each horn is 27" long and 19" at the base, the corrugations are 6½" and 6" clear and the forehead particularly massive.

I shot a fine boar in the same locality. There is no possibility of riding them here. The remoteness as well as the numerous low crowned trees makes pigsticking out of the question.

The year closed with a most extraordinary man-eating tigress incident. I was out with my conservator and we were camped in the thick forest on the right bank about ten miles from the river. Word was brought in the evening that the tracks of a sambhur had been found near the camp, that there was blood on the tracks and that the sambhur had been sprung upon by a tiger and made its escape. My informant thought that by following up the tracks I should certainly come up with the sambhur and so it proved for after going a short distance I came upon the animal and shot it. It had been nearly hamstrung by the tiger but was standing and moving about when I came up with it. The head was 30" good enough for Burma, but poor as Indian specimens go, nevertheless the stag was a full grown one. The meat was brought back to camp.

The sequel was curious and calamitous. The tigress coming back to look for her quarry, found only the blood and entrails. She accordingly visited our camp and found the meat, and in her famished state would have probably seized it but a sleeping Chin coolie close by proved more tempting. She sprang on and clawed his scalp. At 3 A.M. we were awakened by yelling and firing and guessed the reason before being told. The victim had been dropped at once by the frightened tigress and we managed to dress his wound and attend to him so that he soon regained consciousness and a stiff 'peg' even brought him to his feet, but we made him rest till the morning, when he was carried 15 miles into headquarters and taken to hospital where he quickly recovered.

My *lugale* helped me with the washing, lint, bandages and iodine in a most skilful manner with the aid of a Storm King lantern. It was lucky for the Chin that his skull was not broken.

The next man to be attacked was not so fortunate. It was four days later when she actually climbed into a feller's hut 6' or more from the ground and severely mauled a Burman employé laying bare his brain and fracturing his skull in two places. The

men in the camp 14 in number stacked up the fire and sat in a circle round the dying man and while they were so seated, the tigress came again and sprang on another Burman who fell forward into the fire and was slightly burnt. The tigress over-reaching herself touched the hot embers round the fire and quickly made off leaving the third victim mauled on the head and scratched on the body. He however recovered in hospital. A fourth man was slightly scratched by the tigress in her spring. This happened 8 miles from headquarters while I was further afield. On the next day but one I arrived there and sat up for the tigress with A, a Burma Oil Company geologist. All huts and habitations are raised off the ground in Burma on posts, but even Rest Houses so high at 12′—15′ or more off the ground were heavily barricaded. There was no fresh victim however nor did we who were sitting up get a shot. A dog had been poisoned and sent out from the hospital the day before and left in the bed of the stream in case the animal come that way. About 8 A.M. the next morning we heard a tremendous fusillade and rushed suitably armed to the place of the firing where we found the tigress stretched out in its death agony. It had eaten the poisoned dog and was rolling about on the rocks of the stream-bed in great agony and was despatched by the Burmans with S. G. and ball.

The tigress was an old one with worn teeth and was said to have been lame hence its taking to man eating. She was small only measuring 7′ 10″ from head to tip of tail.

The employés came out in great force, everyone in the neighbourhood was soon there, and their comments were curious. "Ho! a Tamanthi tiger" (*i.e.*, from the Tamanthi District) "look at its front feet" said one comparing the shape and placing of the pads and claws with a human hand. The inbabitants of Tamanthi both men and women, are some of them said to be able to turn themselves into tigers and back again as they wish.

Yet another tiger incident. On the 1st August this year I was out after *saing* with the local shikari in a totally different part of Burma near Sangyi, a Forest village 20 miles East of the

railway in the Tharrawaddy District. We found in one place the ground much torn up and tracks as if tiger and *saing* had been coursing round after each other and avoiding and attacking in fact all the signs of a terrific disagreement between them. There was no blood. (*Kya ga ma kaik bu*) "The tiger did not bite" said the shikari. I went on after *saing*. Imagine my surprise when I saw in open bamboo jungle the tiger going from left to right across my front at 50 yard's distance (measured afterwards). I fired and brought him over. My first shot had shattered his right shoulder, made a mess of his liver and broken the other shoulder. At the first shot he appeared to be propped up against bamboos, at the second he fell. Rather excited I fired a third and fourth which I think missed high and a fifth, when I had come quite close, as a precaution. The first shot was a hollow capped 476 bullet and the other—rather unnecessary—shots were solid bullets of the same calibre. By good luck I had put hollow-capped in one barrel and solid in the other.

The time I shot the tiger was 9 A.M. and it had just left thick cover and was going through more or less open jungle. When I saw the animal first, I got an impression of a reddish animal and for a brief second thought it might be a cow *saing* but almost at the same instant saw the stripes and general shape leaving me no doubt.

I enclose you a photo (Plate 3, fig. 2) of the tiger which measured only 7′ 9′ from nose to tip of tail, but whose skin measured 8′ 7″. It was a magnificently developed specimen of a hill tiger as may be seen in the photo.

E.A.S.

THE DEFOLIATION OF GAMHAR (*GMELINA ARBOREA*) IN THE CHITTAGONG HILL TRACTS, BENGAL.

The *gamhar* is a valuable species in the Chittagong District, Bengal. It is used for planking, furniture, door-panels, carriages, boxes, boats, toys, packing-cases and many ornamental works. It is in great demand at Chittagong. It does not grow straight naturally, but in plantations the growth is very rapid and straight.

2

From the measurement of a sample plot in Sitapahar Range, Chittagong Hill Tracts, it is found that the average diameter growth of *gamhar* in five years is five inches and height 51 feet. The biggest tree has 7·45″ diameter and the tallest tree is 59·5′ high. If this rate of growth is continued a *gamhar* tree of 6′ girth can easily be produced in 30 years in the Chittagong Hill Tracts.

Encouraged by the rate of growth and suitability of the soil and the ease with which seedlings are produced from seed regular plantation has been started in all the Ranges of this Division. During the rains of 1924, a heavy defoliation occurred in *gamhar taungya* in Kassalong Reserve, which caused the leading shoots of all the trees to dry up and the tree to remain leafless for nearly four months, especially at the growing-season of the plant. The defoliation has caused a heavy loss of increment and specially threatened the further extension of the plantation. The biggest area of *gamhar* plantations is in Sitapahar Range which is still safe, but none can vouch for its safety. Unless some preventive measures are taken it would be impossible to carry on the plantation of *gamhar* in the Hill Tracts though it would be very profitable financially.

Light injury to the *gamhar* leaves was noticed during the rains of 1923; only a few holes were made in the leaves and nothing more done.

In the 1st week of June 1924 after heavy rainfall the beetles appeared on the *gamhar* leaves After about a week, they laid their eggs on the under surface of the leaves. A whitish net-like thing was found to be deposited by the edges of the under-surface of the leaves, and the leaves coiled themselves up and formed into cells. The eggs remained in those cells and gradually hatched into larvæ. Each leaf was found to contain 4 to 5 cells containing larvæ. These larvæ began to eat up the leaf-parenchyma and within 10 or 12 days ate up the greater portion of the leaves The part which was eaten first became whitish and afterwards brown. The larvæ were about ¾″ to 1″ in length, and after 10 or 12 days turned into pupæ

and remained in that condition for a fortnight, after which the beetle was found on the wing.

It appears that they take about 2 to 2½ months to complete the life-cycle. In September all the insects live in the *Ageratum* growing in the *gamhar taungya*. Some of the beetles also invaded nearby *taungya*, but the attack was not so serious there due to field-crops growing with the plants.

1922 and 1923 *taungya* was completely leafless for over 1½ months. One month after complete defoliation no leaves came up and in September those that came out again were attacked by the beetles. This attack was not very serious.

The attack of the beetle stopped in the middle of October and new leaves began to come up in October. In November the defoliated area was inspected and the larvæ were again found to be eating up the new leaves. One special point is noticed that the attack on leaves is less where the growth of *Ageratum* is plentiful and where the *Ageratum* was cut the attack is heavy. The insects are now living in the *Ageratum*, but not eating up any leaves of that species. Fig. 3, Plate 3, shows the results of defoliation in November 1924.

As a result of this defoliation in the 2nd and 3rd year, the growth is stopped very seriously. At Kaptai, the growth of the *gamhar* is as follows :—2nd year, height 12 ft., girth 4 ins., 3rd year, height 10 ft., girth 5 ins.

The Chittagong Hill Tracts Division has extensive *taungya* plantations of *gamhar*, so any control measure about the defoliation of *gamhar* will be highly welcomed by the Divisional Forest Officer, Chittagong Hill Tracts Division.

M. C. CHAUDHURI, I.F.S.,

Chittagong Hill Tracts.

NOTE BY THE FOREST ENTOMOLOGIST.

It appears likely that this insect, *Calopepla leayana* Latr. (fam. Chrysomelidæ) will prove a pest of primary importance to the cultivation of *Gmelina arborea*. It occurs in the U.P., Bombay, Bengal, Assam and Burma, and of recent years we have received records of serious damage in Ataran and Bhamo

Divisions, Bilumyo and Mohnyin Reserves, Katha Division, Burma; North Barojhar Range, Buxa Division, and Kurseong Division, Bengal; Sibsagar and Cachar Divisions, Assam; and at Dehra Dun. The rains broods in Dehra Dun have a life-cycle of about a month, the first brood maturing at the end of July; beetles live on into November but no larval work has been observed later than September.

Until the biology of the insect is studied no remedy can be suggested beyond hand-collection of the very conspicuous beetles during the earliest broods. Control by handpicking or sweep-nets is simple, effective, and profitable in agriculture, and until costs have been proved prohibitive it is unwise to reject such methods in forestry.

THE CULTIVATION OF CONIFERS IN NORTHERN INDIA.

(Continued from *Indian Forester*, VOL. LI, pp. 4—11.)

AGATHIS.—A genus of from 2 to 16 species according to taste.

A. australis, Salisb., the Kauri pine of New Zealand is a clearly defined species whereas most of the others appear to be geographical forms of *A. loranthifolia*. *Agathis loranthifolia* Salisb., variously known as *A. orientalis*, *alba*, etc., was introduced into the Botanic Gardens, Calcutta, in 1798 and is still grown there. The form or species from Queensland, *A. robusta*, Masters, is grown in Ceylon and Bangalore where it does very well. I have seen pot plants of *Agathis* in northern India but do not remember having seen any established specimens. The seeds do not keep well and the trees are usually dioecious so that seed is not easily procured from Indian grown trees. Plants of this genus are therefore rare in cultivation.

CEDRUS.—Four species of which probably only the Deodar has been tried in the plains where it will grow as a pot plant. In Dehra Dun there are a number of specimens of *C. Deodara*, Loud, some fairly large but they are not satisfactory and scarcely ornamental.

GLYPTOSTROBUS.—A genus consisting of a single species indigenous to wet situations in S. China. The only species usually called *G. heterophyllus*, Endl., is based on *Taxodium heterophyllum*, Brongn., but there are several older names, *e.g.*, *G. aquaticus* based on *Juniperus aquatica*, Roxb., Hort., Beng., p. 73, 1814, nomen.; Fl. Ind., III, p. 838, 1832, descrip. Names based on *Thuya lineata*, Poir., and *T. pensilis*, Lamb., also have claims for consideration.

Roxburgh states that this species was introduced into the Botanic Gardens, Calcutta, from China in 1812. Though mentioned by Voigt it was apparently not living in 1842. The tree should grow in Northern India if given a wet situation.

TAXODIUM.—This is the Swamp Cypress of the Southern United States and is the American representative of *Glyptostrobus*. There is only one species with one geographical and one habit variety. We have plants of *Taxodium distichum*, Rich., growing well in Dehra Dun but they have not been planted very long. The Mexican Swamp Cypress, *T. distichum*. var. *mucronatum* was sown in the Botanic Gardens, Calcutta, in 1914. One small tree is still living in Calcutta but it does not seem to be really thriving and is rather lanky. A plant taken to Lahore in 1915 and planted on the edge of an irrigation channel has done very much better. It is about 20 ft. high and over one foot diameter at the base and has just produced its first crop of cones. In Dehra Dun the Mexican form seems to be rather more vigorous than the type. Plants were planted out at the beginning of the rains this year. I was away when the plants were planted but left instructions that they should be given a moist situation. They got it. The plants were put in a large borrow-pit and when I saw them again one was standing in a foot of water and had been more or less under water for 6 or 7 weeks. I do not know if it was ever completely submerged as the two inches of the tip where the leaves showed no deposit of mud may have been new growth. This plant seemed none the worse for its wetting but had not grown so well as another planted in wet mud and only under a few inches of water for some days after every heavy rain.

The Mexican species would be worth trying for ornament in the hills. In Mexico it is said to form forests at 4,500 to 7,500 ft. and not to be a tree of swamps. It reaches a height of 170 ft. and a girth of over 150 ft. so should not be planted too close to the Forest Rest House. The Swamp Cypress is grown from seed which if not fresh should be soaked in water before sowing. I have failed once with var. *mucronatum* but got very good germination with fresh seed the following year. *T. distichum* was only sown once and germinated badly. With neither form was the seed soaked in water before sowing. The seedlings and young plants do not suffer from the monsoon in Dehra Dun.

CUNNINGHAMIA.—A small genus of two species one of which *C. lanceolata*, Hook., usually known as *C. sinensis*, R. Br., was introduced to the Botanic Gardens, Calcutta, in 1811. It was apparently not living in Calcutta in 1842. This tree grows fairly well in Dehra Dun as also in the hills, *e.g.*, Simla, Chakrata. It is rather too ragged to be really ornamental. In China it reaches a great size but none of the trees in India look as if they would grow very large. The best trees in Dehra are about 40 feet high by 3 feet girth. They cone freely but as far as I am aware they do not produce fertile seed. The stem is usually surrounded by suckers which may be dug up and used for propagation. It is possible that plants raised from imported seed would give better trees than those grown from suckers. I have tried it once from seed but failed to obtain any germination.

PINUS.—Shaw, "The Genus Pinus," recognizes 66 species and it will be convenient to follow his treatment as regards specific limits and names. A great many species of the genus have been tried from time to time and the following references to species is probably by no means complete.

P. longifolia, Roxb.—This species was naturally the first to be tried and was grown in Calcutta before 1794. Roxburgh writing about 1820 or somewhat earlier, refers to small trees growing at Calcutta. It is the only species now grown in Calcutta where however it does not do at all well. It is the only species I have seen in the plains.

P. Armandi, Franchet.—Sown in Dehra Dun in 1913. A few seedlings lingered on in pots for nearly 2 years without showing any signs of vigor.

P. excelsa, Wall.—Some years ago there were two specimens of considerable age growing in Dehra Dun. They were about 12 feet high, stunted and shrubby in growth. One died and the other was destroyed.

P. canariensis, Smith.—This species has been recommended for India but it is unlikely to be satisfactory. We have a vigorous seedling of it which is now ready for planting out unless, as is possible, it is a natural seedling of *P. longifolia* which has come up in the pot where *P. canariensis* was sown. The two species are so alike that without cones it is difficult to distinguish between them. It is also being tried in the Punjab, in Rawalpindi and Simla Divisions.

P. pinea, Linn., was tried in Calcutta in 1799 and according to Voigt did not succeed.

P. densiflora, Sieb. and Zucc.—This species is, I believe, growing well in Chakrata.

P. sylvestris, Linn., was tried in Calcutta in 1810 but failed. It is growing in Mussoorie, also I believe in Chakrata and Naini Tal.

P. montana, Mill., was tried in Calcutta in 1799 but failed.

P. Thunbergii, Parl.—There used to be two specimens of this species growing moderately well in Dehra Dun but they have recently been destroyed for no apparent reason. They were raised from Japanese seed sent as *P. Massoniana.*

P. nigra, Arnold, better known as *P. Laricio*, Poir.—This species is growing in Simla, Chakrata and Dalhousie and does better than most exotic pines in the Himalaya.

P. Merkusii, De Vriese.—We have seedlings of this species in Dehra Dun.

P. sinensis, Lamb.—Said to have been tried in Calcutta in 1811 and was apparently living in 1842, but it seems probable that the species was actually *P. Massoniana*, Lamb., which is much cultivated in Hong-Kong and likely to thrive at low elevations in India.

P. Massoniana, Lamb.—Is said to have been tried in Simla and Rawalpindi in 1918-19 and is reported to have given no success. I do not know the source of the seed but if obtained from a seed-dealer it was probably not *P. Massoniana.*

P. insularis, Endl., better known as *P. Khasya*, Royle.—We have had no success with this species, the young plants damping off. A few seedlings survived for a year and were planted out in the hope they would do better in the ground but they too failed.

P. ponderosa, Dougl.—Sown in May 1921 in Dehra Dun and germinated during the rains but did not look happy in November. By the following June none remained. Var. *Jeffreyi* was also tried but the seedlings damped off almost as fast as they came up and none remained by the end of August.

P. occidentalis, Swartz.—This species was introduced in 1912 under the name *P. cubensis* and is believed to have come from Cuba. It is growing very well in Dehra Dun where there are several specimens. The trees are now 18—20 ft. high and have not yet flowered but appear to be *P. occidentalis* rather than *P. caribæa*.

P. palustris, Mill.—Is I believe being tried in the Punjab.

P. caribæa, Morlet.—This species is under trial in the Punjab.

P. tæda, Linn.—We have seedlings of this species doing fairly well. They have passed through a monsoon without excessive losses.

P. echinata, Mill., better known as *P. mitis.*, Mchx.—Sown in Dehra Dun in spring 1922 but most of the plants damped off in the rains. The survivors steadily decreased in numbers and the last few were planted out but failed to survive the following monsoon. Sown again in May 1923 but all damped off during the rains.

P. halepensis, Mill.—I have tried this species in the hills but did not see the results. It is unlikely to do well except perhaps in Baluchistan.

P. Pinaster, Aiton.—This species is occasionally seen in hill stations and does well when young but as it does not stand snow well it should not be grown at high elevations. The biggest

specimen I have seen is near Almora and it does not look to be thriving.

P. patula, Cham. and Schl.—Sown in Dehra Dun in spring 1922 but all the seedlings damped off as soon as the monsoon started.

P. attennata, Lemmon, better known as *P. tuberculata*.—Tried in Dehra Dun with exactly the same results as with *P. echinata*.

P. Sabiniana, Dougl.—Sown in Dehra Dun in July 1923 but all the seedlings damped off. Sown again in September and gave a few vigorous seedlings which survived the monsoon of 1924 and are looking well.

Pines in India as far as experience goes are very particular as to their climatic requirements. *P. longifolia* although it is found naturally at low elevations and grows well enough in Dehra Dun is not at all happy in Calcutta. In Lahore it is difficult to grow from seed and there are heavy losses of young seedlings. In Dehra Dun the best results with pines have been obtained by sowing the seed as soon as the monsoon is over and putting the seedlings as soon as big enough to handle into separate pots filled with sand. If this is not done seedlings are apt to damp off in large numbers. The excessive losses of seedlings of *Pinus insularis* and *Merkusii* from damping off which caused the almost total loss of large batches of seedlings was not anticipated as these trees are accustomed to a heavy rainfall. Experiments are in progress to elucidate the cause of the "damping off." In the United States, according to Carl Hartley and Roy Pierce, Department of Agriculture Bulletin, 453, damping off is usually due to one of several species of fungus. In some cases similar results to damping off have been shown to be due to strong sun injuring the tender seedlings. Neither of these causes will account for the trouble in Dehra Dun. Fungi were suspected but have not been observed on seedlings which have damped off. Treatment of the soil with sulphuric acid which is effective in controlling damping off in America has had no beneficial results in Dehra Dun. That the trouble is not due to sun-burn is fairly certain as it is worst in the rains and worse in partly shaded beds than in those freely exposed.

At present all that can be said is that in Dehra Dun only two species of pine thrive, *viz*., *P. longifolia* and *P. occidentalis*, the identification of the latter requiring checking as soon as the trees produce cones. Judging by their climatic requirements it should be possible also to grow *P. leiophylla*, Cham. and Schl. *P. tropicalis*, Morelet, *P. Massoniana*, Lamb., *P. Merkusii*, De Vriese, *P. insularis*, Endl., *P. pseudostrobus*, Lindl., *P. Montezumæ*, Lamb., *P. Lawsonii*, Roezl., *P. palustris*, Mill., *P. caribæa*, Morelet, *P. tæda*, Linn., *P. glabra*, Walt., *P. oocarpa*, Schiede, *P. clausa*, Vasey and *P. serotina*, Mchx. In cases of variable species such as *P. Montezumæ* there would be little prospect of success unless the low-level form were tried. Pines are grown from seed which keeps fairly well or by bud-grafting of scarce species on to stocks of the common kinds. I have failed with bud-grafting and I do not think this method of propagation is likely to be easy in India.

PICEA.—Thirty-eight species have been described but the number is likely to be considerably reduced. As far as is known only the two Indian species *P. Smithiana* and *P. spinulosa*, Beissn. are cultivated in hill-stations, the former in the West Himalaya and both in Darjeeling. *P. Smithiana*, Boiss.. used to be represented in Dehra Dun by a small specimen which had been growing for many years, until it was cut down and destroyed. It was about 4 ft. high and made annual growths of only 1—2 inches. None of the spruces are likely to do well at low elevations.

GINKGO.—A single species *G. biloba*, Kaemp. This remarkable tree can be grown in the plains and there is one small specimen in Lahore which has made little growth during the last 12 years. We have one in Dehra Dun now 12 years old but though quite healthy it is only 3 ft. high. There are some good specimens in Dehra which are planted in a very sheltered place on the edge of an irrigation channel. There are a number of specimens in Simla and one very good one in Mussoorie. To do well in the hills it requires a moist situation and still more so in the plains. It is best to grow it surrounded by other trees without however overhead shade. It is of no use for planting at low

elevations except as a curiosity and in Lahore where a considerable number have been planted it cannot be expected to grow more than about 6 inches a year even under the most favourable conditions. Ginkgo is readily grown from imported seeds.

CEPHALOTAXUS.—Pilger in Das Pflanzenreich recognizes six species. I do not think any have been tried at low elevations in India but we have specimens of *C. Griffithii*, Hook., f., from Chakrata. I do not know if this species is still living at Chakrata or if both sexes were cultivated, the specimens show male flowers. The species is in cultivation at Maymyo, Burma.

R. N. PARKER, I.F.S.

THE INTRODUCTION OF MAHSEER INTO THE HARCOURT BUTLER LAKE AT MAYMYO.

The Harcourt Butler Lake in Maymyo is an artificial lake completed in 1920 by the construction of a bund across a rather wide and swampy valley. The lake is fed entirely by springs and covers an area of a little over 100 acres. It was decided to experiment in stocking this lake with mahseer. At the head of the lake there is a small spring-fed pond which was considered suitable for the experiment and attempts were made to introduce a small number of mahseer into this pond in April 1924. Although mahseer are known to occur in the streams not very far from Maymyo, it was considered better to procure the fish from some of the smaller streams in the Bhamo district and Mr. H. Beresford Barrett, I.F.S., was deputed to collect the fish and bring them up to Maymyo.

Bhamo is situated a day's journey by launch above Katha the nearest railhead, and three days by a launch above Mandalay. The streams from which the mahseer were collected are between 15 and 17 miles from Bhamo. It was intended at first to place the small mahseer in teak barrels for transport, but on arrival at Bhamo it was found that the teak barrels were still exuding oil and they had to be abandoned and replaced by large earthenware jars known locally as Pegu jars. The fish were caught

by netting in the pools after the flow of water had been deflected above the pool by a small dam. After catching, the fish were kept in bamboo baskets placed in the stream and were moved downstream in these baskets. In all some 90 fish were caught and were placed in the jars and removed by cart at night to Bhamo. This was carried out satisfactorily. The following morning the jars were transhipped to the launch which immediately started down the river. The launch journey was disastrous. It was very hot and there was little breeze. Attempts were made to keep the water constantly aerated with syringes but were not very successful. The river water at the time was effected by a snow rise and was very "dead" and when this water was used to replenish the jars, it had a very adverse effect on the fish. Only 38 fish were alive on arrival in Katha. Although it had originally been intended to transport the fish by launch right down to Mandalay it was then determined to tranship them by train so as to take them as rapidly as possible to Maymyo. The mahseer survived the train journey excellently in spite of waits at the ferry and Mandalay station in the heat of the day and 36 fish were successfully introduced into the pond at the head of the lake in the evening following the departure from Katha. It would appear that the principal reason for the mortality on the launch and on the contrary, for the success which attended the transhipping by cart and train was the constant shaking of the water in the jars which aerated the water sufficiently to keep the fish alive. To add to this a bamboo net work was introduced in the neck of the jar and this also assisted in the aeration by breaking the surface of the water when it was jolted about by the shaking of the cart or train. As far as can be ascertained up to the end of September there have been no casualties among the fish and although the pond into which they were put is very weedy and it is impossible to see all the fish at a time a considerable number of them have been observed swimming about and Mr. Barrett considers that they have increased at least 50 per cent. in size. Now that the first experiment is a success it is intended to introduce a considerable number of mahseer into the lake direct and attempts will also be made with a limited number of fish to observe them

in a small observation pond. It has now been ascertained that mahseer can be obtained quite close to the railway station at the foot of the ghat leading up to Maymyo and transport would entail only about three hours railway journey so that the prospect of a considerable percentage of survival can be confidently anticipated. Very little appears to be known of the spawning of mahseer and any information readers may be able to send to the *Indian Forester* would be very welcome.

THE DEVELOPMENT OF SAL SEEDLINGS IN GORAKHPUR TAUNGYA.

In the following lines I wish to record some interesting observations on the development of *sal* seedings based on close investigations into the growth of *sal* under the *taungya* system in Gorakhpur Division, U.P.

It has been maintained that as a rule *sal* seedlings stop growing somewhere in October and that they begin again late in March or in the beginning of April.

The West Lehra *sal taungya* in this Division seems to be an exception to the rule.

Before going into the details as to how it does keep growing during practically the whole of the cold weather it is necessary first to lay down the fundamental rules under which such results have been obtained. They are in a nut-shell, (1) good nala-bank type loamy soil, with a fair proportion of sand, dug and aerated to a depth of 18″; (2) sown with fully *matured seed* (I hope to describe in a separate article what I mean by mature seed); (3) kept weeded and clean during the rains; (4) given full overhead light during the whole of cold weather; (5) and more or less immune from frost-bite.

The seed is sown as usual at the beginning of the monsoon. If the seed is fully matured and sown in cool and wet soil the radicle descends into ground with marvellous rapidity reaching within a week, to a depth of 10″ to 12″ while the hypocotyl remains in a more or less dormant state looking just like a red needle. The thick fleshy cotyledons expended all their stores

towards the development of the tap-root alone. When it has reached the desired depth and is capable of drawing its own nourishment from the ground, up goes the stem, clean 5" to 7" to the first inter-node. *And this is my ideal seedling.* The long, clean stem below the first pair of leaves always denotes a correspondingly long tap-root except when mechanical obstruction comes in the way of root-development caused by hard, unbroken, and stiff clay; then the reserve food-store in the fleshy cotyledons wrongly goes to develop the stem instead of the root first, and such a seedling is always short lived on account of the bushy and shallow roots.

To return to the subject, when the first pair of leaves has spread out, it is now again the turn of the root to proceed still deeper, until after 10 or 15 days the leaves again multiply, and in about a month or so perhaps double, treble, or fourfold themselves. Now after this, when it is about the middle of August there are no more additions to the leaves until the end of the monsoon and the whole of September and more than half of October is spent in root development alone.

Now this phenomenon of the apparent cessation in the outward growth in the later half of the monsoon is the second deviation from the old rule. I think the seedling keeps growing upwards in the later half of the monsoon, only in soils, which are not ideally *prepared and suited* for *sal* whereas, in favourable soils, it employs all its energies in pushing down its root alone deeper and deeper when the soil is yet soft and moist and the upward growth remains at a standstill until a sufficiently deep tap-root is ensured.

A proof is obtained in the examples of West Lehra (Sandy loam nala-type) and Campierganj (hard clay *sal taungyas*). Both are treated under the same prescriptions. West Lehra *taungya* ceases to grow in the later half of the monsoon. Campierganj *taungya* keeps growing the whole rains. But the moment the monsoon is over, West Lehra *taungya* starts spasmodic growth at intervals of every 20 or 30 days till May, while Campierganj *sal* stops adding any further height growth or leaves. The roots of seedlings dug up during October in both places showed a

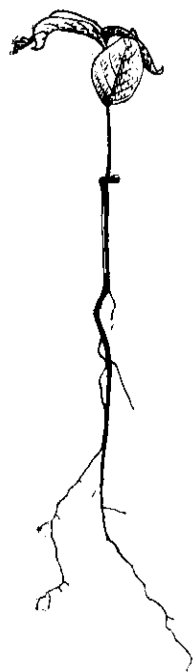


Fig. 1.

A *sal* seedling with healthy root from West Lehra *taungya* four months old (3′ 1″). Note the length and regular tapering root, suggesting a regular and uninterrupted activity in its development. (From a photo by the author.)

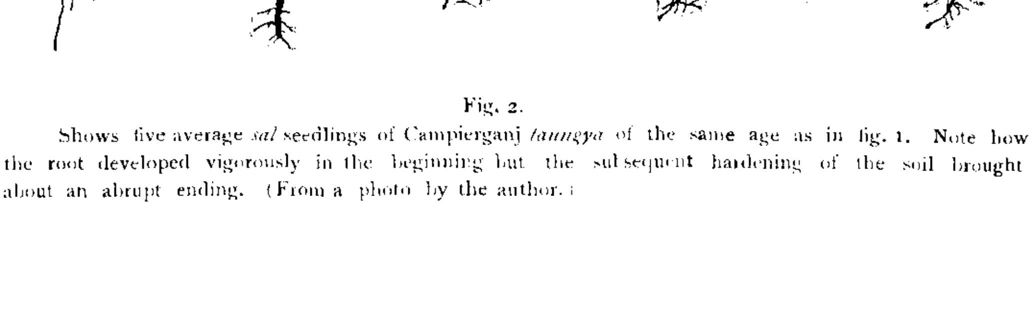


Fig. 2.

Shows five average *sal* seedlings of Campierganj *taungya* of the same age as in fig. 1. Note how the root developed vigorously in the beginning but the subsequent hardening of the soil brought about an abrupt ending. (From a photo by the author.)

remarkable difference. While the one (fig. 1) grew by leaps and bounds in West Lehra, the average being nearly 2′ 3″, in Campierganj the growth was very very poor (fig. 2) and the average was less than half that of West Lehra.

The reason is not far to seek. I firmly believe that the *sal* seedling roots results mechanical obstruction and are not as sturdy as those of *asna*, its close neighbour on such soils, which latter goes on breaking the sub-soil no matter how hard it is. Although, the Campierganj soil is also worked to a depth of 18″ still the stiff and clayey nature of the soil makes it sufficiently sticky and compact after the first two months' rainfall to resist to a certain extent the downward growth of the *sal* seedling tap-root. The result is again the same as was in the case of seed-germination. The stem development during the rains exceeds the food supplying power of the shallow roots with the result that while West Lehra seedlings begin to grow vigorously on the approach of the cold weather their Campierganj brothers are dying back for want of moisture. West Lehra *taungya* goes on putting on new growth during every month from October to May with perhaps temporary cessation in January when sometimes there is very light frost. In the next season again, as soon as the monsoon begins, all outward growth stops, and the healthy plant takes to root development during the rain. But in Campierganj a good many of those seedlings, that had died back during the preceding cold and hot weather shoot up again suggesting thereby, that while the stem had temporarily died back the root was still persisting. Only it (the root) was temporarily unable to support the aerial portion of the plant for want of sufficient moisture.

Apart from the soil there is another important factor which retards the outward development of *sal* seedlings and that is ***shade***. Last year in West Lehra *taungya* the *sal* growing with Rabi (cold weather) crop kept putting on new growth the whole of the winter season, but under *arhar*, which kept the *sal* very much shaded, whatever escaped the pig's teeth did not grow a single inch during winter and as soon as it was opened out in April each and everyone of them died back.

The conclusion, therefore, is that given favourable conditions *sal* does keep growing the year round. When the seedling has well established itself during the first half of the monsoon and has ensured its proper supply of atmospheric gases by spreading out 4 to 8 leaves, it spends the rest of the monsoon days in its root development exclusively, both in length and thickness, which subsequently enables it to shoot upwards in the cold weather. Thenceforward root and shoot development go hand in hand, one after the other alternately every month till May.

M. SHAUKAT HUSAIN,
Forest Ranger, Gorakhpur.

HEIGHT GROWTH OF SEEDLINGS.

The measurements of the periodical height growth of seedlings were published in the December number of 1922 and in the January number of 1924 of the *Indian Forester*. Measurements on *Shorea robusta* have been continued for a further year and new measurements are given for *Adina cordifolia*, *Sapindus emarginatus*, *Ougeinia dalbergioides*, *Acacia arabica*, *Eugenia Jambolana*, *Buchanania latifolia*, and *Spondias mangifera*.

There is little to add to last year's comments. A further set of *Bombax malabaricum* again died down completely in the hot weather and again sprang up vigorously when this year's abnormally late rains appeared.

In the *Indian Forester* of February 1924 an article appeared on the "Evolution of a *Sal* Seedling" in which the theory was advanced that the development from the start consisted in a series of rushes of comparatively short duration with intervals during which the development above ground slowed down and the *sal* stored up energy for the next rush. A further theory has gained ground and seemed indicated last year that the young *sal* increases in height during April, May and June then slows down or stops during July and August and makes a further spurt at the end of September or in October. My measurements do not quite confirm these theories. I think we are

partly misled by the appearance of young bright red leaves in September and October. The history of my measurements on *sal* is that in 1922 the young *sal* began to increase in height in April, quickened in May, attained a maximum in June and then slowed gradually and regularly till October, when it ceased growth. In 1923 growth was greater. It began in the middle of March and from the middle of May to the middle of July showed maximum height increment, it then tailed off greatly but continued to grow till early in October. In 1924 height growth commenced early in March and was rapid but again reached a maximum from the middle of June to early in July but continued rapid growth till the middle of September with a slight decrease in August. It then tailed off and ceased at the end of October.

There appear to be two main types of species in this region—

(1) Those which commence in March or thereabouts and grow steadily on to the end of the rains, *e.g.* *Shorea robusta*, *Dalbergia Sissoo.*

(2) Those which commence at or just before the rains and grow on to the end of the rains, *e.g.* *Acacia Catechu*, *Terminalia tomentosa.*

In each class there are variations as to when maximum growth occurs. Thus in 1924 *Eugenia Jambolana* actually stirred to life in January well before other species and *Ougeinia dalbergioides* continued growing in 1923 till early in November about a month after everything else had ceased. Other species have a very short height growing season indeed. *Acacia Catechu* for instance hardly begins till June and is practically finished by the end of August.

Except as above modified there is nothing to add to what was written last year. These experiments will now be discontinued The table shows the growth each season from the commencement. (See also Plate 4).

The total average heights in inches attained were :—

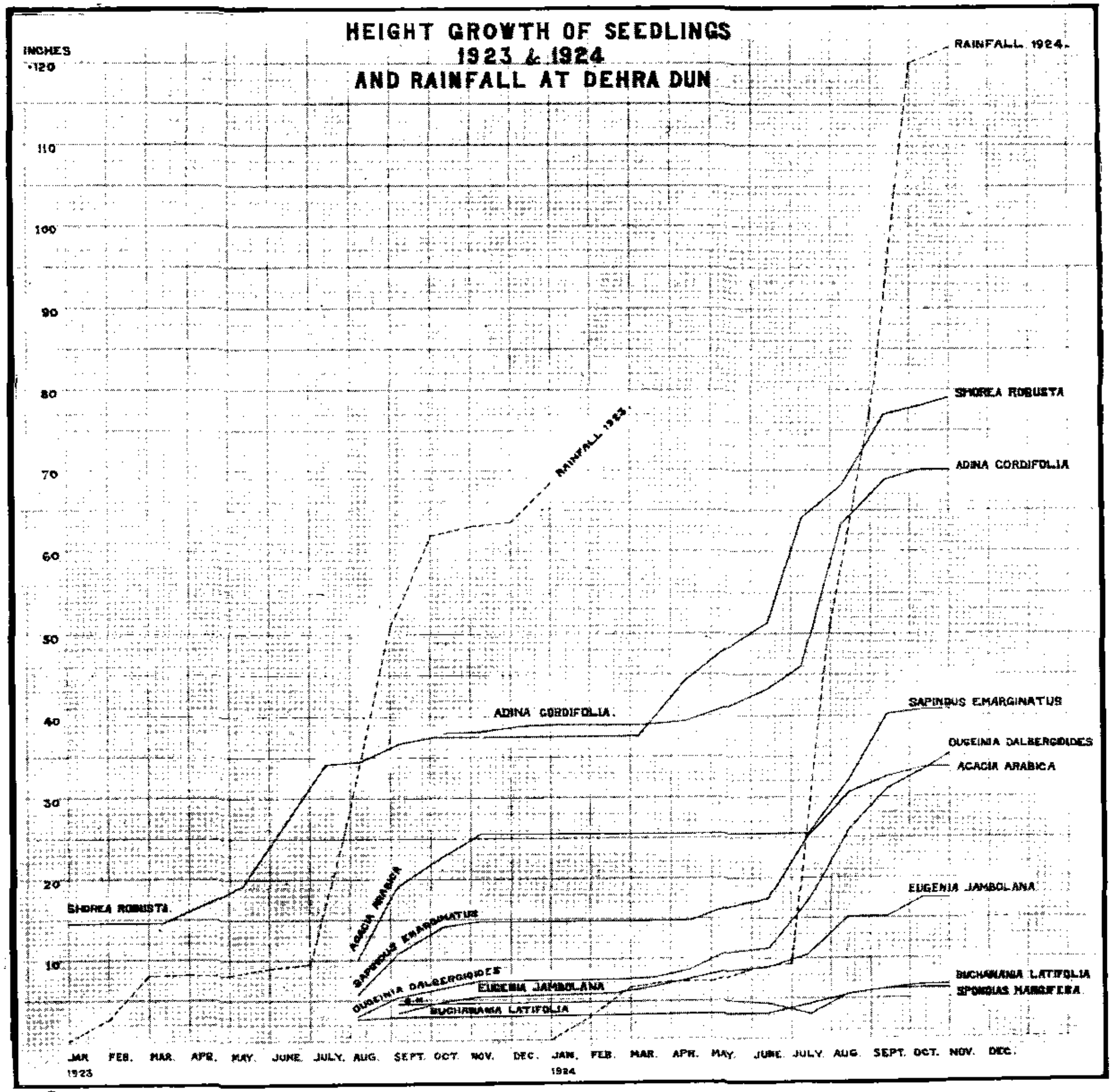
Species.		One growing season.	Two growing seasons.	Three growing seasons.	Four growing seasons.
Shorea robusta	...	4½	14½	37½	79
Terminalia tomentosa	...	12	51	78	Not continued.
Dalbergia Sissoo	...	12	45½	72½	Ditto
Acacia Catechu...	..	30	79	117½	Ditto
Adina cordifolia	...	Not recorded.	Not recorded.	39	70
Ougeinia dalbergioides	...	7½	35½	...	...
Sapindus emarginatus	...	15	41	...	...
Acacia arabica	...	25½	33½	...	...
Buchanania latifolia	...	3	6½	...	...
Eugenia Jambolana	...	5½	17½	...	...
Spondias mangifera	...	4½	6	...	...

S. HOWARD, I.F.S.

MANIPULATION OF TIMBER DRYERS UNDER INDIAN CONDITIONS OF CLIMATE AND LABOUR.

Of the three factors that constitute the process of Artificial Seasoning of Timber—Ventilation, Temperature and Humidity—the first only remains constant from beginning to end of the process, and the other two must be varied in accordance with a predetermined course which has been found out experimentally in the first instance, by the Forest Research Institute, and which is communicated to the person wishing to dry timber, in the *form of a guide chart or schedule.*

The temperature has to be increased gradually, starting a little above atmospheric and rising gradually up to a maximum heat, which is timed to coincide with the fibre-saturation point,


HEIGHT GROWTH OF SEEDLINGS
1923 & 1924
AND RAINFALL AT DEHRA DUN
INCHES
120
110
100
90
80
70
60
50
40
30
20
10
RAINFALL 1924.
RAINFALL 1923.
SHOREA ROBUSTA
ADINA CORDIFOLIA
ADINA CORDIFOLIA.
SAPINDUS EMARGINATUS
OUGEINIA DALBERGIOIDES
ACACIA ARABICA
EUGENIA JAMBOLANA
BUCHANANIA LATIFOLIA
SPONDIAS MANGIFERA
SHOREA ROBUSTA.
ACACIA ARABICA
SAPINDUS EMARGINATUS
OUGEINIA DALBERGIOIDES
EUGENIA JAMBOLANA
BUCHANANIA LATIFOLIA
JAN. FEB. MAR. APR. MAY. JUNE. JULY. AUG. SEPT. OCT. NOV. DEC.
1923
JAN. FEB. MAR. APR. MAY. JUNE. JULY. AUG. SEPT. OCT. NOV. DEC.
1924

or stage where the free water has been extracted, and only the moisture in the fibres remains. This maximum temperature is maintained then until the seasoning is complete.

The Humidity is decreased from an initial stage of high humidity produced artificially by steam vapour, through phases of medium moisture to a final dryness of the circulating air that will complete the seasoning.

These changes are produced by the manipulation of certain valves and dampers and the curves of increase and decrease are integrated into either small or large steps up and down.

The question of how these valves, etc., are to be operated must be considered commercially as well as technically, and taking into consideration the conditions of labour that prevail.

It is quite possible to use Thermostats and Humidostats to operate the valves. These instruments will when set to a certain temperature or humidity, maintain constant conditions in spite of boiler pressure fluctuations or atmospheric changes. A Thermostat is fairly simple as a difference of two degrees will give expansion or contraction on the receiving end, with sufficient force available to close or open a balanced steam valve. A Humidostat is somewhat more complicated as a slight change in humidity will only give minute forces, and therefore a relay apparatus introducing hydraulic power or other servo-motor is *required, directed by the minute strength of the moisture sensitive* " brain " of the apparatus.

Granted all this a Thermostat or Humidostat can only maintain constant conditions. Increase in temperature or decrease in humidity can only be obtained by altering the setting of the directing end of the instrument. If altered at long intervals the steps are somewhat abrupt, if at short intervals it means constant attention.

Alternative to Thermostats and Humidostats is hand-operation and constant attention throughout the 24 hours, necessitating three operators working in shifts.

To decide which to adopt we must take into account labour conditions and costs.

(Automatic Instruments are costly and liable to error, but let us assume that they are gratis and infallible.)

In both cases Recording Hygrometers are necessary to indicate the course and record that this has been followed.

Hand-operation of the valves controlling temperature and humidity is a simple matter as a course is indicated on the recorder and if the pens deviate from this course a slight movement of the valve brings it in line again. True this has to be done at frequent intervals and the evolving effect of night, the heating effect of day sun, and humidity of rain has to be corrected but it all can be done by men of ordinary intelligence.

Automatic instruments need less attention but more expert handling and more expensive men.

In India there is a plentiful supply of men at about Rs. 50 per month, who are quite capable of working the hand-operation, but not equal to the management of the complicated instruments, You can get three men for hand-operation for the price of one who would be equal to the Automatics, and whereas the three cover the 24 hours in three shifts, the one only is present for one-third of the time, leaving the timber at the mercy of the instruments for 16 hours in the 24 and involving big steps in change of conditions.

In countries where the cheapest labour is three or four times as costly as in India there is a case for automatic control apparatus but in India all is in favour of hand-control and constant attention by relatively low priced men, particularly if all humidity calculations are eliminated by using the guide chart course-indicator.

Actual practice shows that Indians of sufficient education are glad to secure these positions at Rs. 40 to Rs. 50 and that after 3 or 4 weeks learning they do excellent work both in operating the dryer controls and also weighing samples and the other routine.

In America, Drying Kilns for timber are generally run to a day by day schedule of Temperature and Relative Humidity. As direct reading percentage Hygrometers are quite unreliable

this means working out the wet bulb equivalent for this humidity at the stated temperature (from table or curve). Heaven knows why they take this extra trouble when the schedule could just as easily be given in terms of dry bulb and wet bulb without mention of per cent. Humidity, which is only interesting in the experimental station where the schedule is produced.

In Europe, Sturtevants introduced the Guide Chart which as it is used on a Wet and Dry Bulb Recording Hygrometer gives the course in terms of the Wet and Dry Bulbs.

The Guide Chart goes on better than the schedule for whereas the schedule is day by day, the Guide Chart having continuous lines is practically minute by minute, showing at any given moment what ought to be the conditions inside the dryer. The position of the points of the pens shows in what degree this predetermined course is being followed, and the ink in the pens leaves record of this.

American Timber Dryer Makers favour a Recording Hygrometer with a circular chart completing 7 days. This is quite enough when working to schedule—it records and that is all that it is asked to do.

Sturtevants use a Recorder in which a strip chart is wound off a spool (like that on a film camera) on to a drum. This drum makes one turn in 7 days and so keeps the chart moving at uniform speed relative to the pens, but charts from 7 days up to 40 or 50 days continuous strip can be used. This covers the time for seasoning most timbers so that only in exceptional cases is the record divided whereas with the circular dial the process is divided up into 7 days circles which cannot be observed together.

As to actual practice with Indian operators, it is found that with the continuous lines to follow, and the immediate betrayal by the ink in the pens, of any deviation, their attention is kept on the work and they produce wonderfully good records, and correspondingly good results with the timber under treatment.

When following a speciality through various countries one has to study the people who are to do the work and their economic conditions.

The best and most wonderful machine or system from one country may not fit in with the people's little ways in another or with the climate, and the arrangement must be altered and adapted. In a cheap labour country labour saving devices are sometimes undesirable as whilst keeping fewer people at work they put more work and responsibility on the management.

With Timber Dryers for India, the simplest system is the best, instruments giving direct observation without calculation and division of work into simple operations.

The Forest Research Institute at Dehra Dun has been picking the brains of the world – Europe and America—on the subject of timber seasoning, apparatus and operation, and having the best varieties known of experimental apparatus to start with is adapting this to Indian conditions and experimenting with most satisfactory results on Indian timbers and with mainly Indian staff (1 European specialist and 9 Indian Assistants and operators) and the results obtained are presented gratis not only to Government departments but to all who want help with seasoning problems for the development of Indian timbers in the most economic manner possible.

STANLEY FITZGERALD.

THE MANUFACTURE OF STRYCHNINE AND BRUCINE

It is a fact well known that India is rich in raw materials and it is regrettable to notice that the raw materials are exported in large quantities to foreign countries. Prospectors have explored the country during the past hundred years; valuable discoveries have been made; enthusiastic schemes have been planned; but capitalists do not come forward and start up industries which, if developed, would really prove assets to the country. The lack of commercial enterprise and the fear of facing early trade competition have been the chief impediments in the starting of industries.

In the list of exported goods is a number of medicinal raw materials from which valuable tinctures and refined drugs could

be made in india. There are at present in India but a few pharmaceutical chemicals manufacturing firms and hence the raw materials are mainly exported to Europe for the manufacture of drugs and a portion of the manufactured drugs are again sold back to us. The important alkaloids strychnine and brucine afford an illustration of these conditions.

Although the tropical regions abound in *Strychnos Nux-Vomica*,—the tree from which nux vomica in its commercial form is obtained,—India, in which this tree has a luxuriant growth supplies the world's demand of this drug, two-thirds being furnished by the Madras Presidency. The Travancore and Cochin Hills on the Malabar coast, and the Ganjam, Godavari and Nellore districts in the Coromandal coast are the important places where this drug is gathered and prepared. Very little attention is bestowed upon the cultivation of this useful tree. They grow wild of their own accord and are generally of medium size though occasional specimens reach 100 feet in height. At the end of cold season, the trees are seen clothed in tufts of dull green and white flowers, which present a charming and beautiful appearance. The fruits develop and mature during the winter and form beautiful brownish-yellow berries. These are as big as a small orange and contain a gelatinous pulp, in which are embedded from one to five button-shaped seeds.

The right of gathering the fruits is preserved by the forest officers and is sold by a system of licenses put to auction annually in the different districts. As a matter of fact owing to insufficient and careless supervision nearly half the commercial supply comes on the market through more or less illegal channels. On account of this and the fact of its wild growth, it has not been possible to obtain an estimate of the amount of crop available either before or after the season. The domestic market is almost non-existant in an organised sense and therefore the production depends upon the price of the substance in foreign markets. So long as the price is high in the foreign markets a vigorous effort is made in gathering as much crop as possible and in periods of low prices practically no attention is paid to the gathering of the crop and much of it is allowed to rot in the forests.

The actual work of gathering the seeds is done by the forest tribes, Ghonds, Maharas and Santals to whom this work is a secondary occupation. After washing the pulp or allowing it to rot, the seeds are spread on a mat to dry in the sun. They then are sold to licensees, or middlemen, who in turn sell them to large licensees, and eventually to the large exporters at Madras Coconada and Cochin who stock them in large quantities. The seeds are washed and sorted by these exporters. The good seeds which sink to the bottom are picked out from the floaters or underweight ones. They are packed in bags of 164 or 182 pounds and sold as "general average of the crop, Europe cleaning." The under-weight ones fetch usually less than half the prices of the cleaned seeds and in years of low demand may remain unsold. The market received its stock of the seeds usually in December and the gathering season extends through the cold weather to March or April. The most important countries of consignment are Germany, England and America.

The seeds are made soft by the process of steaming and by means of a edge runner they are cut and pounded. They are then extracted with alcohol. The extract is concentrated and lead acetate is added to precipitate tannin. The excess of lead is removed from the filtrate with hydrogen sulphide and the alkaloids are then thrown down from the filtrate with ammonia. Brucine is separated from strychnine by its greater solubility in alcohol. Strychnine crystalizes in colourless prisms and brucine in colourless needles.

Of the two alkaloids, strychnine and brucine, the former is important from the medical point of view. It forms a component of most of the patent tonics sold in the market such as Easton's syrup, laxative pills, phosphates and glycero-phosphates of strychnine and quinine, etc.

V. S. CHINNASWAMI, B.A.,
Technical Chemist and Superintendent,
Government Glue Factory, Madras.

UTILISATION NOTES FROM BIHAR AND ORISSA.

Of the many problems in forest development which confront us in Bihar and Orissa that of developing the lac industry is at once about the most important and the one on which principal attention is now being concentrated by the Forest Department. In their manual on Lac and Shellac Messrs. Lindsay and Harlow drew attention to the importance of this industry to Bihar and Orissa which supplies half of the total world crop of lac, and they suggested certain lines of action which the Local Government might take to stimulate the industry, the most important of which was the establishment of brood lac farms in the main lac growing centres. As a start in 1920 the Forest Department acquired an area of 421 acres containing about 28,000 *palas* (*Butea frondosa*) trees at Kundri in Palamau district. Departmental lac cultivation was initiated therein with gradually increasing success. In 1923-24 the Kundri brood lac farm yielded a net surplus of Rs. 10,000 and the total capital invested in the area has now been completely recovered.

The success of the Kundri farm led to further investigations being carried out on the subject of extending lac cultivation. Two, principal lines of action presented themselves. The first was to extend departmental lac cultivation in existing areas of forest under the control of the department. The most suitable areas were selected and departmental cultivation of lac is now being slowly initiated therein. Owing to the fact however that most of our existing forest areas are not suitable for extensive cultivation of lac either through insufficient concentration of good lac hosts, labour scarcity, or other reasons, the scope of lac cultivation therein will always remain strictly limited and it is the second line of action which consists in the establishment of brood lac farms in selected centres which is going to prove of most importance.

In 1923 proposals were submitted to Government to establish numerous plantations of lac hosts to serve the purpose of brood lac farms, and suitable sites were provisionally selected. Apart from their general value as sources of brood lac to the local

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inhabitants, it was calculated that at current market prices for cleaned stick lac such plantations would yield a return of about 20 per cent. on all capital invested and that a return of about 5 per cent. would still be yielded if the market price dropped to so low a figure as Rs. 24 per maund. As a result the Local Government has recently sanctioned the establishment of 15 lac plantations of an average area of 100 acres each distributed over the districts of Palamau, Singhbum and the Santal Parganas, the estimated expenditure thereon of about 2½ lakhs of rupees being spread over a period of the next 10 years. In addition they have sanctioned a further enquiry being made into the possibility of establishing such plantations in the two important lac districts of Manbhum and Ranchi in which owing to the fact that they were non-Government forest districts no sites had been originally selected. Further in another district—Sambalpur—action has already been taken, as prescribed in the 1921 Working Plan for that division, in replanting the annual coupes of one felling series comprising two islands in the Mahanadi river with lac growing species with the intention that these two islands should ultimately become brood lac farms.

The species which it is at present proposed to introduce in the brood lac plantations are *Butea frondosa*, *Schleichera trijuga*, *Zizyhus xylopyrus*, *Zizyhhus Jujuba* and *Acacia Catechu*. The planting distance will be 15′ × 15′ and the spacing triangular giving 222 plants per acre. It is estimated that the ultimate spacing will be 30′ × 30′ so that if 4 different species are now planted alternately the plantation can ultimately be made to consist purely of whatever species gives the best results. The plantations will be properly fenced. Soil analysis will be taken and manuring carried out so as to bring the soil of each up to normal. It is anticipated that with adequate manuring the trees of most of the species will be fit for light infection within a period of 5 years from planting.

On the side of lac research the Forest Department will co-operate so far as field work is concerned with the Indian Lac Research Association the foundation stone of whose laboratory was recently laid at Namkum near Ranchi by His Excellency the Governor

of Bihar and Orissa. The proximity of this laboratory to the summer headquarters of the Local Government has had the effect of stimulating official interest in the industry and it is hoped that Government policy will continue to remain on the present progressive lines.

J. W. NICHOLSON, I.F.S.,
Provincial Research Officer, Bihar and Orissa.

THE EVOLUTION OF PLANTS.

EXTINCT PLANTS AND PROBLEMS OF EVOLUTION, BY D. H. SCOTT, D.Sc., F.R.S. Macmillan and Co., Ltd., London, 10s. 6d. net., 1924.

This book is based on a series of lectures and deals mainly with the more ancient forms of plant life, concerning which Dr. Scott is of course one of our leading authorities. The second of the six chapters, however, gives some account of the history of our recent flora, mainly of the tree forms, as it can be deduced from fossils of Tertiary and Cretaceous age, and it is eminently readable in connection with Berry's "Tree Ancestors." Short paragraphs summarise available data for most of the leading types including not a few not described in Prof. Berry's work, such as *Eucalyptus*, a figure being given of a well preserved Cretaceous fossil form from Bohemia. From the same horizon in Greenland come fossil *Artocarpus* also figured, and *Viburnum* as a representative Sympetalous form. An account is given of still older Angiosperms known only from fossilised wood specimens of Lower Greens and age, and reference is made to the interesting fossil fruits from the Middle Jurassic of Yorkshire which are probably also Angiospermous. Modern conifers are hardly treated with the respect due to their ancient lineage being briefly dismissed in a short paragraph (p. 104).*

The first chapter and the concluding paragraphs dealing with the second part of the title are of much interest: the genera upshot is the emphasising of our present ignorance of all vital points concerning both the phylogeny and the forward evolution of living plants.

H.G.C.

* For a detailed account of coniferous fossils, reference may be made to Vol. IV of Prof. Seward's "Fossil Plants," 1919, which gives an interesting review of the special features of living forms, and a full account of fossil forms. The treatment is however, much too technical to appeal to the general reader.

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PHILIPP'S NEW METHOD OF CONSTRUCTING YIELD TABLES.

Practically the only method which has so far been employed in the construction of Yield Tables is that due to Baur. Various modifications in detail have been proposed and applied since his time, but the essential principle of dividing quality classes by strips on the graph is still the basis of modern yield tables. Experience shows that the method works efficiently where sample plots are derived from a local source with a more or less uniform treatment. But it cannot be applied to a wide range of data without considerable sacrifice of accuracy. There is room therefore for a method based on principles of a more universal nature.

Such a method has been evolved by Karl Philipp, Oberforstrat in Baden. He sought for a factor of the soil which was of the same order of constancy as its quality (*i.e.*, which was independent of treatment within limits), and which would at the same time take account of intermediate yields. The mean height of a stand was known to be practically unaffected by treatment. It was known also, that its relation to the basal area or the standing volume of a wood was very variable. Philipp proposed to overcome this difficulty by assuming that the mean height of a stand is a function of its total volume production. This was not suggested as a strict natural law, but only as a reason-

able hypothesis on which could be based a practical method of constructing yield tables.

It is generally recognised that the mean height of a wood is a very good indicator of the quality of a site. That is to say it is proportional to the productive capacity of the soil. (This statement is only approximately true, since height growth does depend to a small extent on the mode of treatment.) For practical purposes, however, this relation may be assumed to be correct.

If we put **P** for the productive capacity of the soil and for the mean height, then

$$\mathbf{h} = \mathbf{KP}, \text{ where } \mathbf{K} \text{ is a constant.}$$

Now, in any properly grown forest, the entire productive capacity of the soil expresses itself in the production of timber, if the ground is kept clear of weeds, etc. We may then write:

$$\mathbf{V} = \mathbf{K}_1\mathbf{P}, \text{ where } \mathbf{V} \text{ is the total volume produced and } \mathbf{K}_1 \text{ a constant.}$$

Thus $\mathbf{h} = \mathbf{KP}$

$\mathbf{V} = \mathbf{K}_1\mathbf{P}$

$$\therefore \mathbf{h} = \frac{\mathbf{K}}{\mathbf{K}_1}\mathbf{V} \text{ or } \mathbf{K}_2\mathbf{V} \text{ (where } \mathbf{K}_2 = \frac{\mathbf{K}}{\mathbf{K}_1}\text{)}.$$

The above argument shows that the assumption made is not an unreasonable one.

A second conclusion may likewise be drawn from these considerations, which also forms part of Philipp's method. If it is granted that **P** (the productive capacity of the soil) remains unchanged within limits, or in other words, that no litter is removed, nor manure applied, but that the soil is kept as near its optimum as possible, then it stands to reason that the same increment of timber will be laid on, on a hectare, whatever the number of trees it carries, always providing that the soil is not exposed. To put it in another form, for any site, the total volume production over any given period of time is constant. If the number of trees is high, the available

food material has to be distributed among a greater number. There are, so to say, more mouths to feed and each gets less. If the number be few each individual would get more. Thus, although the *individual increment* may vary, the total increment would remain more or less the same. In a wood of low density the trees increase in diameter (and volume) greatly, but they do so only at the expense of their competitors who are now *hors de combat*. The same argument applies to every phenomenon of competition. In a village with several bakers the income of each would be small, but the amount of bread consumed and the total money made in the trade would be independent of the number of bakers competing if bread sells at a standard price. It follows then, that the total increment per hectare and therefore the total volume production is practically independent of stocking, of the degree of thinnings and of treatment in general. This conclusion is supported by the actual experience of Mr. Stephani who controls a private forest at Forbach. His forest consists of three working sections which are worked under three different systems, the uniform, the selection and the *Femelschlagbetrieb* systems. He finds that the increment per hectare is practically the same, the only difference being in the quality of timber produced.

Mr. Philipp is far from asserting that either of these generalisations has any rigid accuracy. Since yield tables are found to be a practical necessity, they must be constructed on some acceptable basis. *It is not very difficult for academic criticism to point out theoretical defects in the above assumptions. In fact Philipp himself claims that he can take a doctor's degree at any university by writing a thesis attacking these conclusions.* For example, we are not justified in assuming that the productive capacity of the soil is strictly constant. This would be absolutely false in agriculture, *but in forestry the fluctuations are negligible.* Again, tree-growth is not solely a function of the soil factors. According to the Swiss school, it depends as much on the carbon dioxide of the air as on the contents of the soil itself. In fact, M. Biolley goes so far as to say that in forestry the air is about twenty times as important

as the soil! Nor are temperature and rainfall to be disregarded in considering the phenomenon of growth. A recurrence of severe frosts may destroy all increment. A warm year stimulates growth. Drought retards it. It must be remembered, when all is said and done, that timber is not an essential product of plant metabolism; it is only a *waste product.* And in the active periods of plant life, a great deal of energy (or increment) is spent on flowering and seeding and is totally lost to us. This might be one of the reasons why the current annual increment fluctuates in the way it does. It would be not very difficult to multiply these objections. But, nevertheless, not much error is involved in assuming that the total volume produced on a site over a given period of time is proportional to the mean height of the wood and is practically independent of treatment.

Moreover, when we consider the narrow limits within which these differences of treatment range in actual practice, we can see that no serious error is made in the above postulates. In Germany, for instance, thinnings vary between 30 to 50% of the total volume production. A hypothesis is by definition a working scheme, which is to be judged by its results. This is the test which should be applied to Philipp's ideas.

The advantages of these assumptions are at once evident. If the mean height is plotted against the total volume, the curve so obtained would be applicable to all quality classes and would thus be of universal application. A wood of the third quality with a mean height of 20 m. would have the same total volume as a wood of the first quality with the same height, the only difference being that while the former took a longer time to reach that height, the first quality one took a shorter time to do so. This curve, however, will not show the volumes corresponding to each particular age. For this purpose, an age-height curve has to be constructed for *each quality class.* Philipp proposes to divide his quality classes on the basis of their mean annual increment at the end of the rotation (say, 100 years). Quality 18, would then signify a site with a mean annual increment of 18, *i.e.*, with a total production of 1800 m^3 in 100 years. The old arbitrary division of sites into I, II......qualities conveys no precise idea

and generally implies a loose aggregation of plots with greater or less productivity. The adoption of a common site index for species is desirable. One suggestion (American) is to classify the trees into groups based on their total growth in height at a definite age. Such a standard has been adopted by the British Forestry Commission. The classification of sites by their mean annual increments is a better system and has some of the advantages of a chemical formula. It has a definite quantitative significance. Q. 16 would produce 1600 m^3 in 100 years. There would thus be as many qualities as there are values for the mean annual increment. For the sake of convenience, Philipp proposes to divide quality classes with a difference of 1 m^3 mean annual increment at 100 years.* This is the classification which is adopted in the following yield table:—

THE PROCEDURE IN PHILIPP'S METHOD

The actual procedure in constructing a yield table by Philipp's method is as follows :—

About a hundred sample plots of all ages, heights, qualities, and methods of treatment are measured carefully *at least thrice* for intervals of five years. The oftener they are measured the better. No reliable yield table can be constructed out of single measurements only. The total volume (*i.e.*, including brushwood) should be calculated in each enumeration.

It is not necessary to exercise any selection as regards the normality of sample plots. All healthy woods in which the soil is kept covered are normal. The species must of course be *pure*.

The "*form heights*" for the trees measured should be calculated. In practical forestry, the "form height" is a more useful figure than the "form factor." It is obtained by dividing the volume by the basal area of a tree.

$$\mathbf{V = shf}$$

$$\text{Form ht.} = \frac{\mathbf{V}}{\mathbf{S}} \text{ or } \frac{\mathbf{shf}}{\mathbf{S}} = \underline{\mathbf{hf}}$$

* In an economically advanced country like Germany this classification of quality classes with a difference of 1 m mean annual increment is no doubt feasible. Nothing in Philipp's method, however, precludes the possibility of classification by larger differences, say 2 or 3 m mean annual increment depending on the number of quality classes required

The form height is the product of the height into the form factor.

Philipp has investigated the relation between the form factor and the factors of the locality and the condition of the wood. The following table summarises his results:—

—	Timber Form Factor	Tree Form Factor
Age	Does not vary.	Does not vary.
Diameter ...	Varies.	Varies very little
Height	Varies slightly.	Varies.
Habitat ...	Does not vary.	Does not vary.

In yield table work, only the tree form factor is to be used as this includes timber and brushwood.

Now, in order to find the total volume production corresponding to each particular height, the height-increment and the volume-increment in every sample plot for each five-year period is calculated from the results of measurements. The result is then expressed as so much *volume increment per metre increment of height* between the two actual heights (at the beginning and end of the period). An example would make this clear.

In sample plot 1 (see appendix), the difference in height for the interval is (28·4—27·6) m. The difference in the standing volume for the same interval is 37 m. The thinnings for the period 60 m³.

∴ Betn. 27 m. and 28 m., 0·8 m. increment of height corresponds to 97 m³ of volume.

∴ For 1 m. of height increment betn. 27—28 m. the volume increment would be $\frac{97}{0\cdot 8} = \underline{120\ m^3}$.

The total volume production corresponding to each height is given by the sum of the increments of volume up to the height in question.

The next steps are—

1. The height and total volume production are plotted on squared paper and the relation between them shown by a curve.

2. The heights of the different quality classes are fixed from this curve for the year 100 (R = 100) for differences of 1 m^3 mean increment. For example the height corresponding to 1800 m^3 is read from the curve and this represents the volume produced in 100 years. The annual increment would then be 18 m^3 per hectare and the quality is spoken of as quality 18. The question now arises as to how the highest quality is to be fixed. This is done by finding from the sample plot measurements, the maximum height actually attained in 100 years. The volume corresponding to this represents the maximum productivity with reference to the given species, *as far as can be ascertained from the data.* Let us assume that the height so found is 31·6 m. and the corresponding volume is 1800 m^3.

Once this is fixed, the heights for 1700, 1600, 1500, etc. (Q17, Q16, Q15, etc.) are all obtained from the curve.

3. The mean heights of the sample plots are plotted as a function of the age. It is essential that the same woods should have been remeasured as often as possible so as to get broken lines.

4. The mean height-age curve is then drawn for each quality class. The height at 100 years for Q18 has already been obtained. This is plotted on the graph and affords us a fixed point through which the curve must pass. The curve is then drawn carefully so as to embrace as many of the outermost lines as possible and so as to run as closely parallel as possible to the general direction of the broken lines. Great care is necessary, since small errors here tend to get multiplied in later calculations.

5. Thinning strips should be drawn on the height-total volume curve. This is done by taking 85 per cent. of the total volume corresponding to each height and the calculated values are plotted on the same paper. The curve so obtained would lie below the first curve. Similarly a curve is drawn for 75 per cent., 65 per cent. and 55 per cent. Then the strip between 85

per cent. and 75 per cent. may be taken to represent an average of 80 per cent. of the total volume, *i.e.*, 20 per cent. thinnings. The lower strips would represent 30 per cent. and 40 per cent.

6. Now all the sample plots should be classified according to thinning classes by plotting them on the above graph. (This is not shown in the accompanying photograph of the curve.) All sample plots falling on the 30 per cent. and 40 per cent. strips are respectively classified. This would also show how the same sample plot falls into different strips at different periods of its life, thus revealing the want of uniform and systematic treatment.

7. The diameters of each *thinning class* are plotted as a function of the heights. A table for finding the average diameter for each height is given in the appendix. By this method, only sample plots which have been uniformly treated are taken into consideration. This marks a great advance on Baur's methods.

8. The final yield for each age is obtained by calculating 70 per cent. in the case of 30 per cent. thinnings and 60 per cent. in the case of 40 per cent. thinnings, of the total volume.

9. The form heights corresponding to each height are read off from a form-height-height curve for which data should be available from the sample plot measurements.

10. The basal area of the wood for each age is obtained by dividing the final yield by the corresponding form height.

$$\mathbf{V} = \mathbf{s.h.f.}$$

$$\text{Form ht.} = \mathbf{h} \times \mathbf{f}$$

$$\therefore \mathbf{S} = \frac{\mathbf{V}}{\mathbf{h\,f}}$$

11. The number of stems is determined by dividing the basal area obtained above by the cross-section corresponding to the diameter for each age. This is easily done with the help of tables.

It will be noticed that in all the curves the ***mean height is the common factor.***

12. The intermediate yield for each thinning class is calculated by taking 30 per cent. (or 40 per cent. as the case may be) of the *difference* in total volume production for each 5-year-period.

13. The current and mean annual increments are calculated directly from the total volume production.

It is obvious that the diameter, final yield, basal area and number of stems should be given for each thinning class.

The following table summarises the whole procedure :—

Yield Table for Silver Fir Quality 18.

Age.	Height.	Total volume.	Current annual increment.	Mean annual increment	Thinnings 30%.						Thinnings 40%.
					Diameter.	Form height.	Final yield.	Inter yield	Basal area.	No. 4 stems.	
5 10 15 20 25	Read from height age curve.	Read from height-total volume curve.	$\frac{\text{Dif.}}{5}$	÷ 15	Read from height-diameter curve.	Read from height form-height curve.	70% of total volume.	30% of difference between successive readings.	$\frac{\text{Final yield.}}{\text{Form height.}}$	$\frac{\text{Basal area.}}{\text{Cross-section corg. to diameter.}}$	

A glance at the yield table will show that both the mean and the current annual increment are independent of the degree of thinnings—a fact to which reference has been made earlier. The current annual increment is a specific property of plants and though it is true that the individual increment is responsive to stimulus, it has been shown that the total increment on a hectare is probably constant. This is the logical conclusion of Philipp's assumptions and on its validity rests their truth.

The yield table also shows that the intermediate yields gradually rise from early youth to middle age, reach a maximum at 70 years and then fall off. It will be seen at once that this is precisely the way in which the current annual increment behaves. There is in fact a fixed relation between the two .It follows from this that the thinnings ought to keep pace with the current annual increment becoming more severe as the latter rises.

Advantages of Philipp's method.

(1) All healthy sample plots can be used independently of their previous history, normality, etc.

(2) A method is provided for classifying data according to their treatment. This is also valuable for control.

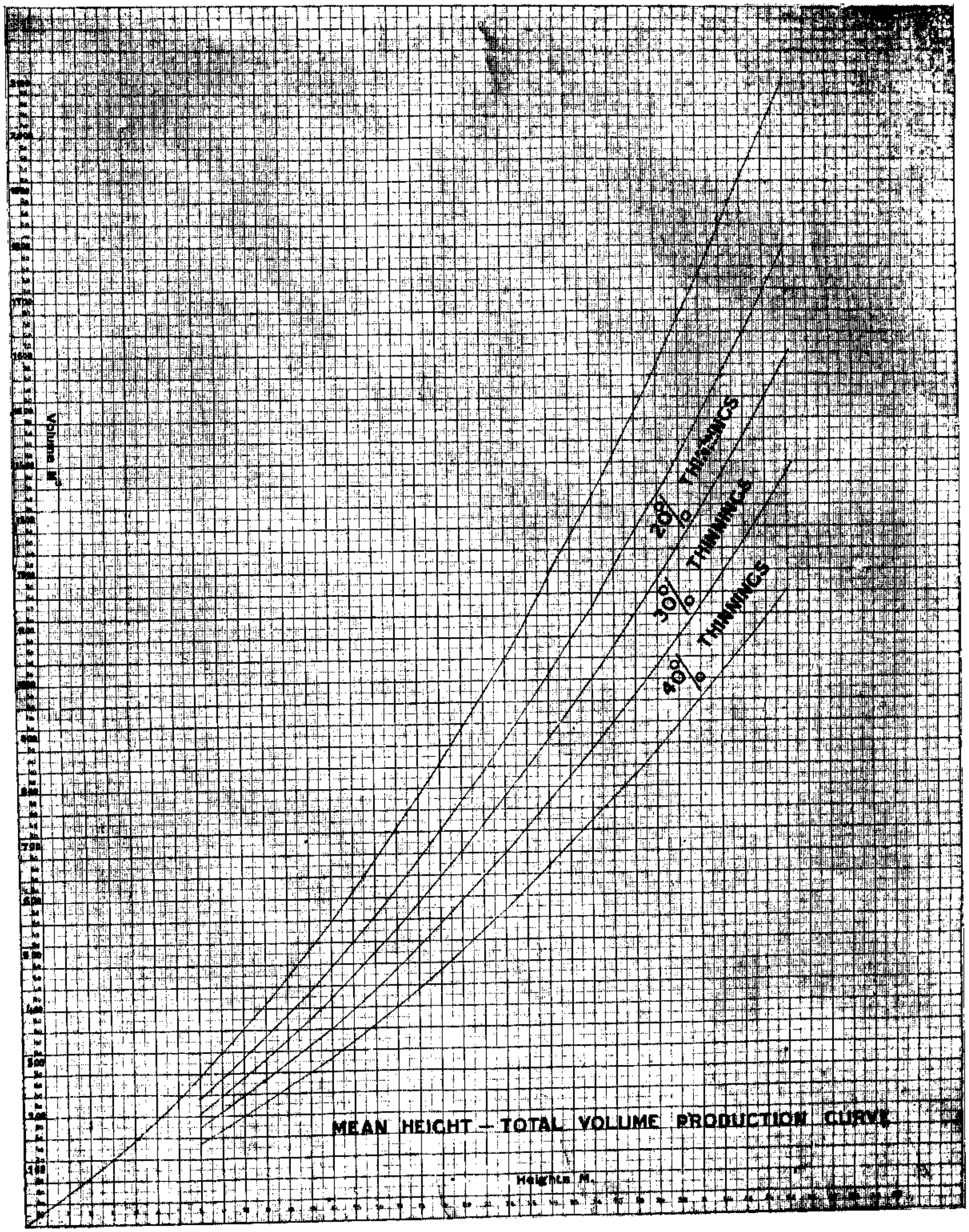
(3) Errors, if any, will be on the safe side, since all figures whether low or high, are considered and nothing is rejected.

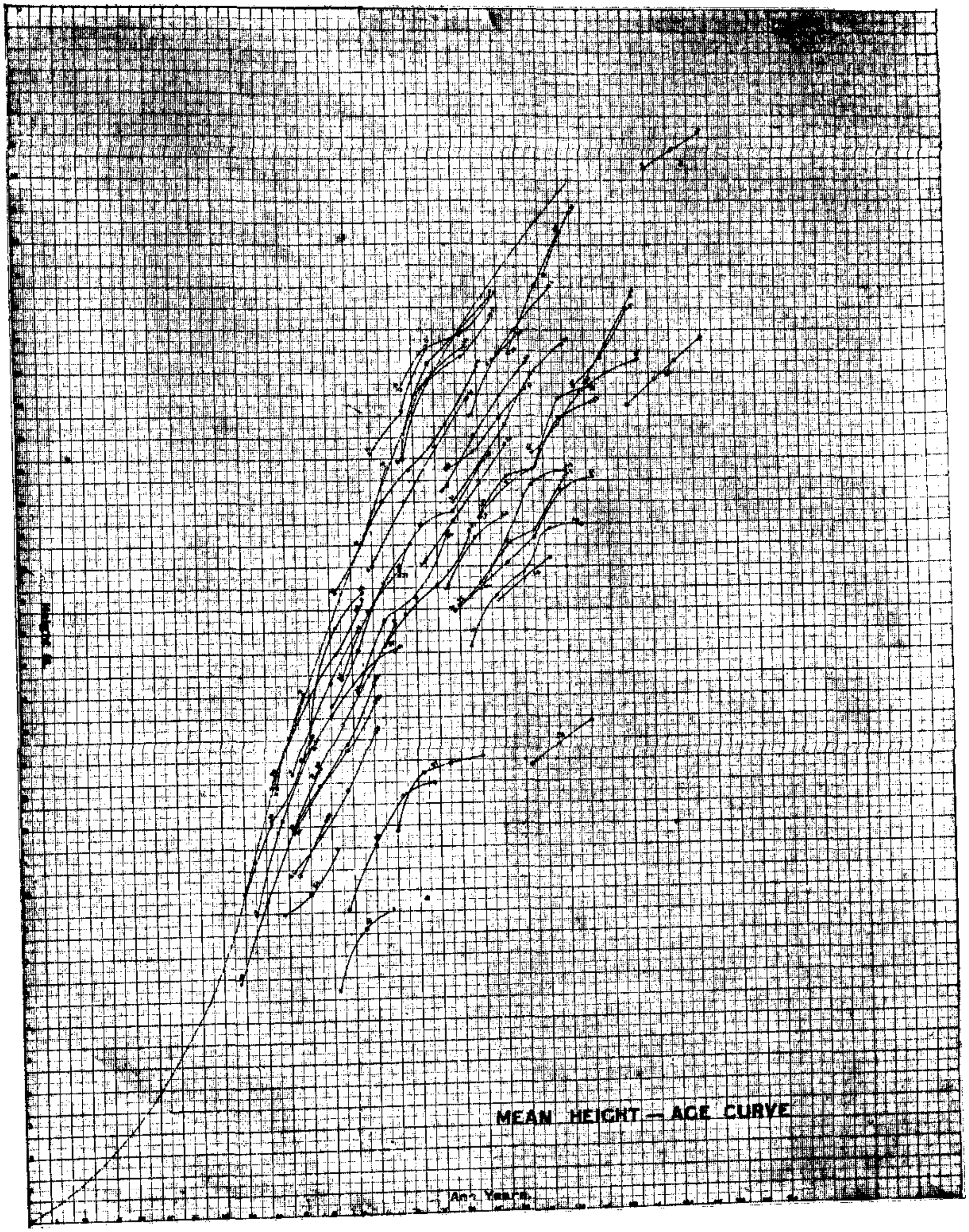
(4) The essence of Baur's method was an artificial classification of his material into quality classes and the yield table figures were derived from this classification and were liable to the same errors. Philipp's method arrives at a factor common to all qualities, for which all sample plots may be used and the yield table figures are derived from this, *viz.*, total volume production-height.

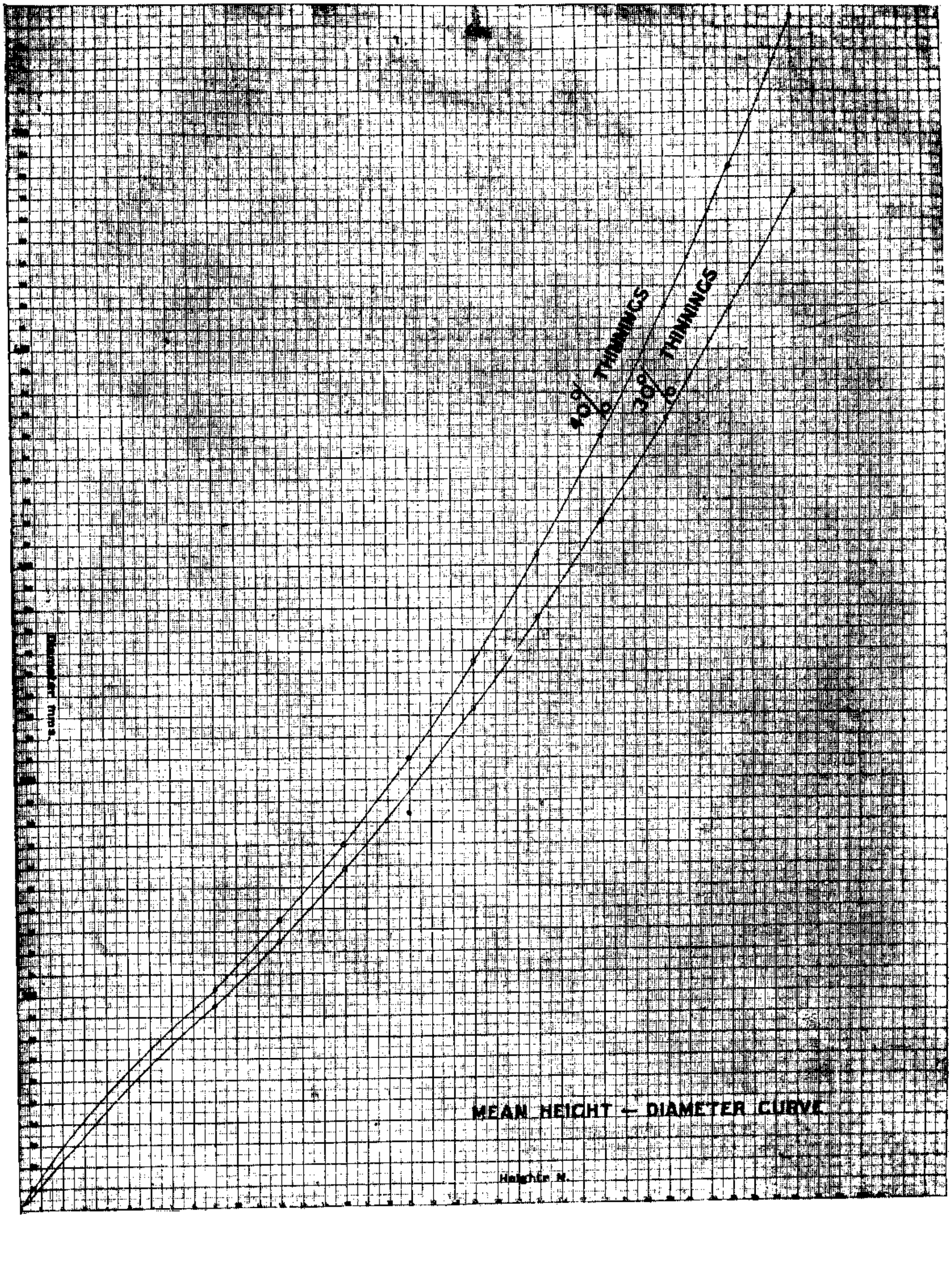
[NOTE.—A copy of the figures on which this yield table is based has been filed in the Sylviculturist's office. The accompanying Plates show the mean height total volume production curve ; the mean height age curve ; the mean height-diameter curve. Owing to lack of space the height-form height curve has not been reproduced.]

C. R. RANGANATHAN, I.F.S.

[*See plates 5 to 7.*]


20% THINNINGS
30% THINNINGS
40% THINNINGS
MEAN HEIGHT – TOTAL VOLUME PRODUCTION CURVE
Heights M.
Volume M³


MEAN HEIGHT — AGE CURVE
Years.


40% THINNINGS
30% THINNINGS
MEAN HEIGHT — DIAMETER CURVE
Height M.
Diameter mms.

YIELD TABLE FOR SILVER FIR.

Quality 18 and mean annual increment at 100—18 m³ per hectare.

Age.	Mean height m.	Total volume m³.	M. A. Increment, m³ P. hectare.	C. A. Increment, m³. P. hectare.	Thinnings 30%. Diameter mm.	Form height.	Final yield m³.	Inter yield m³.	Basal area m².	No. of stems.	Thinnings 40%. Diameter mm.	Form height.	Final yield m³.	Inter yield m³	Basal area m².	No. of stems.	Age.
5																	5
10																	10
15																	15
20																	20
25																	25
30	5.6	180	6.0	10.8	62	5.1	126	16	24.7	8,230	71	5.1	108	22	21.2	5,300	30
35	7.3	244	7.0	12.8	80	6.0	171	19	28.5	5,700	87	6.0	146	26	24.3	4,120	35
40	9.9	365	9.1	24.2	104	7.3	255	36	34.9	4,100	112	7.3	219	48	30.0	3,030	40
45	12.9	500	11.1	27.0	135	8.8	350	41	39.8	2,840	145	8.8	300	54	34.1	2,070	45
50	15.4	636	12.7	27.2	163	10.0	445	41	44.5	2,150	176	10.0	382	54	38.2	1,570	50
55	17.8	772	14.0	27.2	192	11.3	540	41	47.8	1,650	207	11.3	463	54	41.0	1,220	55
60	19.9	910	15.1	27.6	219	12.4	637	41	51.4	1,360	238	12.2	546	55	44.0	990	60
65	22.1	1,050	16.1	28.0	248	13.5	735	42	54.4	1,120	273	13.5	630	56	46.7	800	65
70	24.1	1,192	17.0	28.4	277	14.5	834	43	57.5	955	307	14.5	715	57	49.9	670	70
75	25.7	1,312	17.5	24.0	301	15.2	918	36	60.4	848	336	15.2	787	48	51.8	580	75
80	27.1	1,420	17.7	21.6	322	15.8	994	32	63.0	774	362	15.8	852	43	53.9	523	80
85	28.4	1,524	17.9	20.8	342	16.3	1,067	31	65.4	710	389	16.3	914	42	56.1	472	85
90	29.5	1,620	18.0	19.2	360	16.8	1,134	29	67.5	663	411	16.8	972	38	57.9	436	90
95	30.6	1,715	18.1	19.0	378	17.2	1,201	29	69.8	622	433	17.2	1,029	38	59.9	406	95
100	31.6	1,800	18.0	17.0	396	17.5	1,260	26	7[illegible]0	584	455	17.5	1,080	34	60.2	370	100

NOTE BY THE SILVICULTURIST.

This extremely clear account of Philipp's method by Mr. Ranganathan will interest all who have to deal with these matters. It is worth considering whether the method can be applied at present to our work in India. I have been unable so far to obtain Philipp's own account of his method nor the criticisms of his German contemporaries. I have not had time to study and test the method in detail as Mr. Ranganathan has described it. I am rather hoping that comments in the *Indian Forester* will bring out the salient advantages and objections and thereby save me labour. I would, however, point out certain matters as they strike me at first perusal.

Philipp's basic assumption is that the total volume production over any given period of time is constant irrespective of treatment so long as no abnormal methods such as removal of litter or the application of manure are introduced or at any rate not much error is involved in assuming this. As the whole of the method hinges upon this assumption it should be very carefully examined.

Philipp considers the assumption reasonable but does not attempt to prove it.

Economists state that the Law of Diminishing Returns is "a general law of production and can be formulated thus: every increase in yield requires a more than proportional increase in power." That is what the modern economist says but even the classical economists knew the law as applicable to the agricultural and extractive industries. Alteration in methods of cultivation has been known to change the produce of soil from very ancient times. To me it would be an extraordinary thing if forests should prove an exception to this law and one modern economist (Taussig) specially instances forests as subject to it. On general grounds therefore I think Philipp's assumption is not reasonable but unreasonable. The mere fact that economists have formulated these laws of increasing and diminishing returns implies that treatment can alter production,

To come to more practical reasons. If production is not influenced by treatment it seems that much of our time has been wasted learning silviculture at all and experiments on methods of thinnings, etc., are useless if it is expected thereby to learn a method of getting greater production. In fact it assumes that thinnings are powerless to increase production.

Most people in India have seen the soil quality in places improved by treatment and, to take a reverse case, it has been recently shown that the system of clear felling in Germany has decreased the soil productivity. In another connection I recently quoted other examples where treatment had apparently altered production.

As a last instance take a *sal* area under a short rotation to supply fuel and *ballis,* say 20 years. Philipp's assumption seems to be that to raise this 20 year crop from coppice stools would give the same total production each 20 years as to raise the crop each time from freshly sown seed. I think that will hardly be believed in India.

Therefore I think we must ask for some proof of Philipp's basic assumption—something more than a statement that it is reasonable.

There are certain practical difficulties in the way of the application of the method in India. For instance, it seems to require 15 years before any result is obtained. Next, the basis of calculation is a measurement of height increment. Now everyone who has done this work knows that height is about the most difficult increment to measure accurately even with trees which show rings and have a leading shoot and is very sketchy indeed with those that do not.

Lastly it appears to be essential to the method as stated to measure "the total volume *including brushwood.*" When I picture my sturdy silviculturists toiling up and down the Himalayas with buckets of water and xylometers to measure the brushwood of a large crowned *chir* which has slid down 500 ft., or imagine them searching out the ultimate twigs of a really large *sal* well covered with red ants preferably in the hot weather, I almost pray for the introduction of the method to get some of

my own back but I fear that if this is an essential condition it will not be too well received.

These are the difficulties and dangers of the method. But though I should like to see more proof before accepting it as a method it certainly contains several useful hints which are worth investigating. Even without this question of total production and measuring brushwood there are points which may be adopted If any practical adaptation is found here or sent up by anyone it will be tested against our present methods *when* there is any staff available to do more than routine work. The idea of making a yield table by the addition of successive increments is excellent but is not entirely new. Increments are recorded in the last columns of the form for measurements per acre here for that purpose though no method has yet been written up for it. It is on these points that possibly much useful material can be got even without proof of the basic assumption. If that is proved the method would at once merit much more serious consideration

S. HOWARD, I.F.S.

THE FIR FORESTS OF THE PIR PANJAL, KASHMIR.

(Continued from Indian Forester, LI, pp. 49—53.)

In the previous article, it was mentioned that the fir (*A. Pindrow*) forests of the Pir Panjal appear to be exceptional as compared with the fir forests in British India. This statement is perhaps misleading as it tends to suggest as if there is something intrinsically wrong with the Kashmir forests, whereas it is the latter forests which deviate from the normal condition. It would be far more accurate to add that the fir forests of the Pir Panjal are enjoying optimum conditions of growth and that they approximate closely to the *beau ideal* of existence.

It is very difficult to lay a finger upon the exact causes which bring about this consummation in the case of the fir forests in Kashmir, but in all probability climatic factors play an important *rôle* in determining the distribution and purity of these forests. In the first place, it must be mentioned that the rain-

fall in Kashmir is much less than in other parts of the Himalayas the force of the monsoon being considerably reduced by the interminable chain of mountains which encircle and embosom the valley. Thus, for instance, the average annual rainfall at Srinagar seldom exceeds 26", or 40" at Kulgam at the foot of the Pir Panjal, as compared with 57" at Murree, 72" in Chakrata, 78" in Dehra Dun and 96" in Mussoorie. The rainfall at Gulmarg (8,569') is a little more than in Srinagar, but even here it is not more than two-thirds that of Murree (6,344'). This decreased fall of rain in summer, however, is more than compensated by heavy fall of snow in winter which covers the valley for several months in the year. The following table brings out more clearly the distribution of rain during summer and winter and compares the rainfall of some of the stations in Kashmir with those in British India.

Comparative statistics of rainfall (including snowfall).

No.	Name of station.	Rainfall during the monsoon months, *i.e.*, June to September.	Rainfall during winter, *i.e.* December to March.	Total annual rainfall.	No. of years recorded.
1	Srinagar, Kashmir ...	7·53	10·57	25·73	30
2	Kulgam, Pir Panjal, Kashmir.	10·96	17·85	39·28	18
3	Kulu	17·85	14·43	39·19	53
4	Chakrata	52·91	13·00	71·68	42
5	Murree	35·24	12·17	56·90	53
6	Mussoorie	81·05	9·24	95·60	57
7	Almora	31·12	6·55	42·40	52

It will be seen that while in the British Himalayas the bulk of the rain falls in summer, *i.e.*, during the monsoon months but does so in winter in Kashmir. The comparatively heavy fall of snow in Kashmir will be evident from the fact that while the precipitation in winter in Kashmir forms as much as 35—45% of the total annual rainfall, in British India it forms only 15—25%

occasionally rising to about 40%, *e.g.*, Kulu. But even in the case of Kulu, it will be observed that it conforms more with other hill stations in India than Kashmir in that the rainfall in summer exceeds that in winter. *The distinguishing features, therefore, of the Kashmir climate are: decreased rainfall in summer, increased rainfall in winter and heavy fall of snow.*

Each of these factors is sufficiently potent and has a marked effect on the distribution, physiognomy and ecology of the prevailing types of vegetation. The time of the atmospheric precipitations, *i.e.*, the season in which rain falls is of very great importance. Where rain falls in winter, hot and dry seasons coincide, for which reason the vegetation has a xerophytic impress, whereas the same quantity of rain distributed in summer mitigates the evil effects of excessive transpiration, and favours a more mesophytic form of vegetation. This would partly explain how the local conditions prevailing in Kashmir, namely decreased total annual rainfall, particularly decreased rain in summer, tend to favour the equilibrium in favour of xerophytic conifers as against such mesophytic forms of vegetation as the oaks, laurels and rhododendrons. The latter, however, flourish in British India sometimes at the expense of the conifers) because timely rainfall, in sufficient quantity, is generally available in summer. The higher the total annual rainfall in the Himalayas, the greater the luxuriance and variety of the oaks, laurels and other mesophytic forms of vegetation and the greater their preponderance over the associated conifers. It is, therefore, that the number and variety of the oaks and laurels generally increases as one progresses further east from Dehra Dun towards Darjeeling.

The factor of rainfall alone may not be sufficient to account for the marked absence of the above broad-leaved species from Kashmir, but it is very much aided and reinforced by the twin factor, namely heavy fall of snow in winter. The latter also favours the conifers at the expense of the broad-leaved species, because winter must be regarded as *physiologically* dry and the more so the more it is prolonged and the heavier the fall of snow. These two factors between themselves turn the scales in

favour of xerophytic conifers as against the above broad-leaved species.

The very heavy fall of snow also explains why the silver fir (*A. Pindrow*) descends so low in certain places in Kashmir. For obvious reasons, the descent is much lower in deep gullies, wet depressions and in sequestered side-valleys as the Gratnar than in other places.

The effect of these climatic factors on natural reproduction is still more marked. In British India, the summer rains increase the humidity of the atmosphere at a time when the temperature is already high. This awakens into life a large number of aggressive weeds which compete with the regeneration of the conifers, and very often choke up the established regeneration. On the other hand the absence of heavy summer rains in Kashmir effectually keeps down some of the aggressive weeds thereby eliminating competition. Snow also exerts a decidedly beneficial influence in that it maintains a constant supply of water during spring, *i.e.*, at the time of the germination of the fir seedlings.

Thus while the heavy snowfall enables the young seedlings to tide over the critical period of their life by warding off drought the decreased rain in summer indirectly benefits regeneration by eliminating competition with weeds. To a certain extent the fir regeneration is also aided by its marked capacity to spring up in dense shade. But the main reason why fir regeneration is so abundant on the lower slopes of the Pir Panjal must be sought for in another direction, *i.e.*, the geology of this part of the Himalayas. While the Jammu side of the Pir Panjal is cut up into precipitous faces, the northern presents a very gentle slope with characteristic " writing desk " outline. This easy gradient of the Pir Panjal is in sharp contrast to that of other Himalayan Ranges, and to the same must be ascribed the richness of these fir forests, the glory of these mountains. Dr. Neve has given a picturesque description of these mountains in his inimitable style. " Most of the hill stations of Northern India " writes the Doctor " are built along mere ridges where the steep slopes have to be terraced, and where it is difficult to find a level space large enough for a tennis court. In Kashmir there is no such difficulty.

The conformation of the mountains is such that fifty Simlas might be built on comparatively level ground on the Kashmir side of the Pir Panjal Range."

These lower flat and gently inclined valley parts or the foothills of the Pir Panjal are locally known as *karewas* and consist of great thicknesses of interstratified soft sandstones and partially hardened clays. These *karewas* afford indubitable evidence of lacustrine origin, *e.g.*, beds of lignite containing water-nuts such as now grow in the Wular. These plateaux therefore date back to the time when Kashmir was occupied by a lake of great depth, which covered the whole of the present valley. These beds of alluvium are several hundred feet deep and afford excellent germinating beds for the development of fir seedlings. There is very little doubt that the fine quality of the fir is also, in no small measure, due to the great depth of these beds of alluvium. Indeed, were it not for these *karewas*, the quality of the fir would not be so fine as it is at present, and the reproductivity of the fir would also suffer to a degree. This is proved by the fact that on the upper slopes of the Pir where the rocks are more solid, consisting of trap schists, etc., and where the soil is correspondingly shallow, the fir rapidly falls off in height growth, and the regeneration becomes practically non-existent. Thus, the beneficial effect of climate in this part of the country is very much heightened and reinforced by that of the soil.

Lastly, we must consider in this connection, the effect of grazing in so far as it bears on the regeneration of the fir. Partly on account of its easy configuration and partly on account of the liberal attitude of the Durbar towards the graziers, the Pir Panjal is overrun each year by large herds of sheep, goats and buffaloes which come from all parts of the Kashmir valley and the Jammu Province. The incidence of grazing would be gathered from the fact that the State collects annually grazing fees to the tune of over one lakh of rupees from this part of the country. These graziers have cleared small areas in the forest to which they resort early in summer to return late in autumn. The whole of the forest is honeycombed with these petty clearances or tiny *margs* as they are locally called. Grazing, therefore, comes prominently

into play in these forests and it is observed that while excessive grazing produces disastrous results, light grazing does little or no harm. This would be evident from the fact that the areas which now bear excellent masses of fir regeneration are all open to grazing. Indeed, it is possible that light grazing may be a blessing in disguise, accounting partly for the excellence of the fir regeneration, in this part of the country. In that case, the beneficial effect of grazing should not be attributed to the keeping down of weeds, for as already mentioned, there are very few local weeds, and such as do exist, namely *guchh (Viburnum foetens), nera (S. Laureola), gandelu (S. Ebulus)* are not browsed down at all. Grazing is useful in that it serves to mix up humus with the mineral soil, thereby promoting its disintegration and preventing the formation of a thick carpet of semi-decayed needles so that the seedlings can directly get down to the soil underneath.

While realising the good effects of light grazing innumerable cases could be cited in which grazing has progressed beyond the limit of safety and in which cases the ground is trampled so hard that the radicle cannot penetrate soil. The forests in the basin of the Veshau river are typical in this respect, the regeneration being markedly deficient although the local soil and climatic conditions are exactly similar to other parts of the Pir Panjal. Grazing to be useful must, therefore, be controlled. In other words the excellence of the fir regeneration is due mainly to the local soil conditions favourably assisted by climate and light grazing.

The climate of Kashmir approximates closely to that of Europe and it will be seen that the fir forests of Kashmir come nearer to the fir forests in Europe than other fir forests in India From the point of view of fertility of the fir, the Pir Panjal must, therefore, be regarded a veritable oasis. From other points of view also these fir forests are quite unique. Indeed, they are a real *rara avis* among other Himalayan fir forests.

SHER SINGH, M.SC.,
Kashmir Forest Service.

TAUNGYA IN GORAKHPUR FOREST DIVISION, EASTERN CIRCLE, U. P.

The photographs in Plates 8 and 9 give the reader some idea of the *taungya* work being carried out in the Gorakhpur Division. It is believed that the system has a great future before it and at no distant date may be able to solve the problem of artificial regeneration on larger scales in a good many divisions in the U. P. The local conditions would always vary from place to place and each locality will have to evolve methods suitable for its own requirements.

For instance, in places where there is the danger from frost, *arhar* (*Cajanus indicus*) or cotton will always be a suitable companion to be grown with frost-tender forest species. But very careful attention will have to be paid towards fencing the area as *arhar* affords a good shelter-place to pig—a proved enemy of *sal* seedlings.

Of course the *taungya* system entirely depends upon cultivators, being willing to take forest land, and in a good many places the unhealthy climate and the scanty local population might discourage one at the very start, but if the horizon is not very bright in the beginning there is no reason to become a confirmed pessimist. The history of so many *Grant Lands* throughout the Province should be a sure stimulant. These areas were perhaps even more unhealthy and dreary, with almost no means of transport in the good old days when the Grantees began to inhabit them. The question of shifting every 4th or 5th year from one place to another does not worry the cultivator very much so long as he be given some other fresh and virgin land to cultivate. Hence, in a good many places, though it might be necessary to bring in cultivators from outside, once the thing is started it will keep going.

The ratio in the growth and production of field crops on forest lands as compared to that in the outside zamindari is 3 : 2, acre to acre. This fact alone, if properly demonstrated and proved before the cultivator, is a sufficient inducement to pursuade him to become a forest tenant. The writer who proved this fact to the local cultivators knows of some instances in which

cultivators of limited means preferred the forest land and gave up the zamindari cultivation altogether. Labour, to an Indian cultivator, does not count and he certainly prefers to pay the rental in the form of labour, if this can leave his little purse untouched, which in other words, only means the grain which keeps him alive the year round. The U. P. being essentially an agricultural province a good deal of the peasant's time in the year is spent in idleness, although his expenses, for his and his family's up-keep continue all the same. So that if by judicious persuation he is asked to pay the rent of the land in labour instead of grain he is always only too willing to do so.

The system of work, the tending of seedlings, the best and most suitable agricultural species which may be profitable to both parties, the measures necessary for protection against wild animals and a host of other things connected *with the system, if* discussed in detail, would, the writer fears, form a too lengthy article, and it is preferred to leave them alone for the present.

M. SHAUKAT HUSAIN,
Forest Ranger.

DESCRIPTION OF THE FIGURES IN PLATES 8 AND 9.

The cultivator is allowed to have his own crops in the 1st year and *sal* is sown only the next year. The cultivator digs out all stumps in the preparatory year and at the beginning of the next hot weather digs out one foot trenches 18 feet apart and 18 inches deep throughout his field. These trenches, after inspection, are re-filled and *sal* is sown in them at the commencement of the monsoon.

Fig. 1.—This photo shows the 2nd year's work. The seed was sown at the break of monsoon and the photo was taken when *sal* was 4 months old. Paddy has already been reaped and *Rabbi* has been sown. There is no stump left now.

Fig. 2.—This photo shows 3rd year of *taungya*. The *sal* lines are 1 year 4 months old. *Rabbi* has been sown between *sal* lines. Unfortunately there is not much left of this age as pigs did very considerable damage last winter, for the cultivators were

Fig. 1.

Fig. 2.

Fig. 3.

M. Shaukat Hussain.

Fig. 4.

Taungya in Gorakhpur, U.P.

For description see opposite page.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

M. Shaukat Hussain.

Taungya in Gorakhpur, U.P.

For description see opposite page.

allowed to grow *arhar*, which, however, proved a fatal mistake as it afforded a good sheltering place to pigs.

Fig. 3.—A trench fencing 3′ by 4′ devised by the writer to keep the pigs out. A stout wooden fence pitched on the top of this trench can make the area invulnerable to all animals. Look at the amount of work the cultivator is willing to do for us.

Fig. 4.—This photo shows a low-lying grassy blank in the middle of *sal* forest. *Asna* (*Terminalia tomentosa*) is sown on mounds raised as high as flood level, 18 feet apart from each other. The intervening space is sown with paddy. The photograph was taken in August when paddy had grown to mound level. Still some of the bunds showing tiny *asna* seedlings are visible.

Fig. 5.—Same locality as fig. 4. The photo was taken when paddy was reaped and *Rabbi* sown. The *asna* lines are 4 months old.

Fig. 6.—Same locality as fig. 4. The photo shows *babul* (*Acacia arabica*) sown as an experiment mixed with *asna*. The maximum growth put by this species in 4 months was 4 feet one inch.

Figs. 7 & 8.—Show another low-lying grassy blank in *sal* forest sown with *asna* last year. The photos show *asna* 1 year 1 month old. Look at the rice growth.

Photos by M. SHAUKAT HUSAIN,
Forest Ranger.

A PIONEER FOREST OFFICER.

The Nilambur teak plantations are too well known to need introduction. Few, however, know or realise that we owe their inception to the genius and foresight of an English Civilian and their successful establishment to his Indian Assistant, much past the prime of his life and innocent of sylviculture, or any culture for that matter, usually associated with equipment of a modern Forest Officer.

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In the year 1840, struck by the remarkable growth of teak in the Nilambur valley, and alarmed by the prospects of its rapid

extermination at the pace it was then being exploited, Mr. H. V. Conolly the Collector of Malabar, not only put a stop to the cutting of undersized teak, but also took the memorable move which has to-day resulted in the famous teak plantations of Nilambur, more valuable acre per acre than any other forests, at any rate, in India. This Civilian has written his name large in the history of the land not by these plantations alone but also by a canal called after him, which connects Malabar with the great backwaters of Cochin and Travancore, and renders navigation possible from Trivandrum to Calicut and further north. Before the advent of the railway, this canal formed the principal highway for the commerce of the land, and contributed, indeed even to-day contributes, not a little to its economic prosperity. Mr. Conolly was also reported to be a good and kind administrator. Few Civilians have left behind them such kind memories or standing monuments of their wisdom and greatness as Mr. Conolly. It is sad to contemplate the most unfortunate end of such a man, who gave of his best to the land which he administered. He was hacked to death by the Moplahs, in the presence of his wife.

The year 1840 was taken up in acquiring the lands necessary for the plantations, and in 1841 Mr. Conolly started work. A Mr. Smith was put in charge of the sowing and planting operations, but as they were attended with little success, he was replaced in 1842 by a Sergeant Graham. The gallant sergeant resigned his appointment six months later, unable to stand the discomforts of the life any more than the attentions bestowed upon his untrousered person by the good folk of Nilambur whenever he had to cross the streams. He was succeeded by Mr. Chathu Menon, the subject of this article, whose interesting and chequered career is worth narrating.

Pazhur Chathu Menon was born in 966 M.E. (1788-89). The Pazhur Tarwad (family) is an ancient middle class Nair Tarwad in Puliyakkot, now Pulpatta Amsom, Ernad Taluk, about a mile to the north of the Manjeri-Calicut road, about 6 miles from Manjeri. Although not very rich the Pazhur people were quite well-to-do and respectable. They were the hereditary

Pattola Menons (Secretaries) of the Nilambur Tirumulpads. The first Pattola Menon was one Kelu Menon who was reputed for his knowledge of toxicology and cures for snake-bites. One of Chathu Menon's ancestors was a poor financier; and, before he died, managed to encumber all the family property beyond hope of redemption. When Chathu Menon was born there was only the ancient name of the Tarwad left, but neither lands nor money. Almost all the Tarwad lands, including the ancestral house were in the possession of a neighbouring Moplah, the principal creditor.

Education under the circumstances was of course out of the question. Not that it was very costly. Good education, Malayalam, Sanskrit, Arithmetic, Philosophy as general courses, and Astronomy, Astrology, Medicine, Architecture, as special, was very cheap almost free in those days. But food and clothing were greater needs than education to a boy in poor Chathu Menon's position, and he had set about earning them very early in life, that is, as early as he was able to wield a stick with sufficient force to exact some amount of tardy obedience from a few head of domestic cattle much as it is to-day. But thanks to the religious traditions of the land no caste-born child could entirely escape acquaintance with the alphabet. All caste-born children after the third and before the fifth year are put through a ceremony of scholastic initiation, when they are formally presented to the Goddess of Learning, "*Saraswati*" and made to repeat the alphabet, their little fingers guided at the same time, to form the letters on some sand spread on the floor. Many drop the acquaintance thus made; a few cultivate it; and some just manage to keep themselves on nodding terms with it. Chathu Menon belonged to the last class.

All his years after the time when he could wield the cowherd's stick till he was about 20, Chathu Menon was a cooly, working mostly on his own lands, but for the benefit of his creditor, the Moplah. Although a poor, uneducated cooly, it would appear, that from his very early days the boy exhibited a certain amount of family pride, which counted poverty for nothing, and birth and respectability for everything. This trait in his character which marked him throughout his life, jarred on his employer,

and gave rise to frequent friction between master and servant. And finally the crisis happened, which changed the fortunes of the servant and of the master also. Chathu Menon was then a youth of about 20 to 22 years. He was ploughing all day for the Moplah, and in the evening when he went to receive his wages in paddy, finding nothing to take the grain home in, he cut a leaf of a banana tree from the Moplah's garden. The Moplah abused him for this, the cooly retorted, whereupon the Moplah struck him. Chathu Menon could not stand the insult, and left home the same night, determined never to return unless he could pay off his creditor and exact from him the respect due from a Moplah to a Nair of his social status.

The young man had a sort of regard for one Uralath Nair, in Nediyiruppu, who had shown him some kindness before; and to this gentleman he betook himself first. Here he was received kindly, given a decent *mundu* (loin-cloth), also some good advice, and sent on his travels with the good man's benediction to lighten his soul and four cocoanuts to sustain his body. He next went to a distant branch of his family in Ravanatkara, near Feroke, who were in better circumstances. Here he was treated as a servant rather than a member of the house, and he naturally felt himself slighted. If serve he must to earn his living, he thought it better to serve strangers; and therefore, left his relatives and went to Calicut in search of employment. Here he happened to meet a rich landlord one Aluvingal Kurup, in Kezhakkumbram (the East-end) to whom he narrated his history. The rich *jenmi* took a liking to the youth and employed him as his personal servant.

He must have remained in the service of this gentleman for some time—how long, one cannot say. It is certain, however, that he rose in his master's esteem and was his most trusted servant. Good feeding and good clothing had improved his person and appearance, and better associations his mind and manners; so that it was a very well-set, smart and capable-looking servant that the Collector's Sheristadar, a very big man in those days, found when he visited his friend the Kurup. The Sheristadar, when he left, wanted to take away Chathu Menon

with him. But the Kurup disliked parting with his favourite servant. At the same time he did not like to displease such a big official as the "Zilla" Collector's Sheristadar. In the meanwhile, Chathu Menon had conceived new ambitions. Visions of a peon's place in the Collector's office, and a belt and silver badge began to dangle before his eyes, and he wanted to go away with the Sheristadar, much as he loved his kind patron and master. Thus pressed both by his guest and his servant, the Kurup yielded and Chathu Menon changed masters.

It was not long before Chathu Menon realised his first ambition, for he pleased his new master so well that he was soon appointed a peon in the Collectorate. But he continued to work under the Sheristadar, as his personal peon. Then (probably when that officer retired) he was sent to work in the office, and sometimes detailed for duty in the Collector's house. During this period he learned to read and write Malayalam well, and also to talk Hindustani fluently. Shrewd and smart and of stalwart physique, he soon rose in favour and in a few years was promoted as Daffadar.

As Daffadar, Chathu Menon had once to go to Camp with a Collector to Wynaad. During this camp he so pleased the Collector with his excellent *bandobust* that on their return to headquarters he was made a Clerk. His natural intelligence cultivated by his self-acquired education, his keenness and application to duty, enabled him soon to make his mark at the desk also, and earn rapid promotion. Then they discovered, or he asserted, that he was worth much more than a quill driver; and the upshot of it was that he was appointed to the coveted post of "Kotval" (Magistrate) and posted to Tellicherry.

The officers of the Honourable East India Company made, not a meagre living, as their prototypes under His Majesty do now, but their fortunes. One need not turn up one's nose at the paltry—often 2 digit-figures representing their pay. The rupee had much more magic in it then than now; it went a very long way, bought more food and clothing and other things But the pay counted for nothing in those days. It was paid perhaps as a salve to the conscience of the employers, and

received as a token of servitude. The perquisites of office made more than ample compensation for the paltry pay. It is not surprising, therefore, that Chathu Menon within a few years of Magisterial power was able to amass sufficient money to pay off his creditor and retrieve his ancestral properties. It was a glorious return home; and it is said that he paid off the Moplah, not only his pecuniary debts, but other debts also. Had not the family lost all its records during the recent rebellion, it would have been easy to fix the date of this home coming and all subsequent events of importance in his life.

His next appointment was as Excise Officer at Nilambur; but it is not now possible to say when it was, or how long before he was finally translated to the Conservatorship. An Excise Officer was required at Nilambur because it was at the outermost edge of inhabited country on one of the trade routes from Mysore, Wandoor being the first market which absorbed the imports coming this way. Tobacco, opium and *ganja* were contraband articles and used to be smuggled into Malabar in large quantities by this route. Chathu Menon's job was to put a stop to this. He appears to have done excellent work in this capacity also and pleased his superiors. Otherwise Mr. Conolly would not have selected him later, for carrying on his pet project of teak planting when Sergeant Graham resigned his appointment in April 1843.

It was then at an age, when we his successors in office think of retiring, in his 54th year to wit, that Chathu Menon entered on the most arduous period of his chequered career. And for 19 years thereafter, till he retired on an honorary pension in December 1862, he carried on with remarkable success the great project of Mr. Conolly, undaunted by waning strength and increasing acreage. Before he retired he had established successfully 1,700 acres of the plantations, that are now the pride of the Forest Department in Madras. Some of his plantations still stand, while some have been cut. Walking through those which stand or scanning the accounts of those which have been cut, one cannot fail to be struck by the magnitude of his achievements,

ill-equipped as he was for the job, handicapped by age, without trained staff or labour.

He died in M. E. 1044, in his 78th year, six years after his retirement. He was a dark, tall, well set up man, very grave and deliberate in disposition and manners. He took his duties always very seriously and devoted to them all his attention and energy. As Sub-Assistant Conservator, he seems to have been very proud of his job signing himself as he always did as "Conservator, Chathu Menon." Nor was this empty pride; for he took his work more as his own pet hobby than as a duty. To put it in the words of his old cook still living, "he had only one daughter but he loved his teak plants more than her." Old as he was then, he would get up at 4 in the morning, have a *hot bath and a substantial meal—a very substantial and elaborate* affair, according to his cook—and be out with his coolies by 7. The whole day he would stay out in the plantations working with the coolies as one of them. He did not eat the usual midday meal, but sometimes had a light tiffin, while more often was satisfied with some water only. Returning home at dusk, he would have another bath, this time usually in the river, and his dinner another substantial and more elaborate affair than the morning meal.

At Nilambur he was living at "Parakkal" now a portion of the Kovilagom (or Palace) of the Tirumulpads. It was his own house. The Tirumulpads bought it from his descendants only comparatively recently. The main building is still the same, the Tirumulpads having built only some extensions to it.

He was given magisterial powers over Nilambur and a few neighbouring amsoms (villages) to enable him to recruit labour for the plantations. He had a permanent gang of coolies, but sometimes wanted more. He was a trusted advisor of the Tirumulpads, whom he is said to have obliged and benefited in many ways, some of them not quite proper, though. But the good that he did lives after him and if the evil was not interred with his bones, it has at any rate now, almost faded into oblivion, and there let it rest. There is no doubt that he wielded a lot of power in Nilambur and that people feared and respected him.

His office was behind the present motor-shed in the Kovilagom and the ground where it stood is still called "Kacheri Pura Paramba" (Office Compound).

Chathu Menon's wife had died before he came to Nilambur. He had a daughter who was married to one of his nephews, Raman Menon by name, and they had three children. He had given his daughter and her children a house and some lands attached to it. His grand and great-grandchildren were a bad lot, however, and they have lost the property now. It may be mentioned in passing, just to show how fate plays its pranks with its dolls, that a great-grandson of Chathu Menon was a peon in the District Forest Office here and was dismissed with six months sojourn in His Majesty's jail in addition, for helping himself to some of the District Forest Officer's private cash.

His Tarwad still exists but not in the flourishing state he left it. The big house he had built is in disrepair, and the majority of the lands are either lost or heavily mortgaged. One Ramunni Menon, a nephew of his, must take the primary responsibility for this second decline of the Tarwad. He was a Police Inspector, but got into trouble and was either dismissed or forced to resign. Later he was employed as a Ranger at Nilambur under Mr. Fergusson and was again dismissed or forced to resign. A debauchee of the worst type, when out of employment, he drew upon the Tarwad freely for all his extravagance. When Chathu Menon died the Tarwad possessed two elephants, and lands yielding a rental in paddy worth about Rs. 7,000 a year, at current rates. Raman Menon sold both the elephants and left the lands heavily encumbered. His successors have not arrested the decline, although some of them have managed to put a brake on the speed and delay the crash.

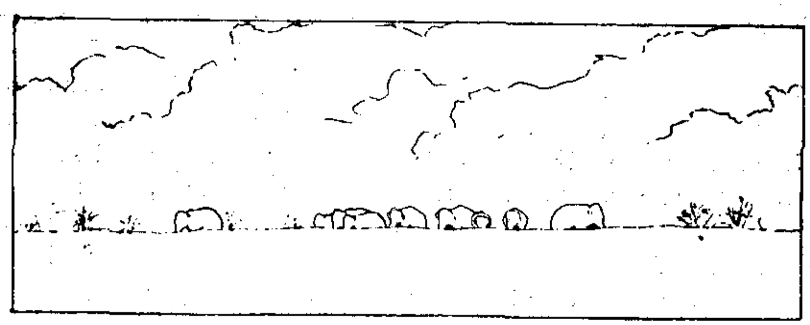
A great grandnephew of Chathu Menon is a Forester now in service here. In point of size, he certainly maintains the reputation of his worthy ancestor.

P. GOVINDA MENON, E.A.C.F.

THE POSSIBLE OCCURRENCE OF ANOTHER SPECIES OF WILD ELEPHANTS, NEAR THE INLAND SEA, IN THE PROVINCE OF SINGORA, SOUTHERN SIAM.

I believe it has been held for some time past by some authorities on the Southern Siamese Peninsula, that a peculiar distinct breed of wild elephants exists in the narrow strip of country which lies between the Inland Sea or Talê Sap and the Gulf of Siam, also in the areas immediately adjoining this tract of country. This breed is said to be different to the Indian elephant, which is the ordinary species of elephants throughout the Malay Peninsula and the Indo-Chinese regions.

Mr. Warington Smyth, the author of the well-known book "Five years in Siam" delivered a lecture before the Royal Geographical Society entitled "Journeys in the Siamese East Coast States" which was published in the May 1898 number of the Geographical Journal, volume XI, No. 5.



Wild elephants in the country north of the Inland Sea, Singora Province, S. Siam.

In this lecture he stated as follows (page 477 of the journal). "The plain (lying between the sea and the Inland Sea) is inhabited by a small breed of elephants known as Chang Deng (red elephants), owing to the reddish colour of the bristles. These animals, largely owing no doubt to their peculiar diet and the brackish water they drink seldom grow to a greater height than 8 feet and have unusually small heads and large bodies. They are very wild and much given to marauding expeditions on their neighbours; they have 'let in the jungle' on all would-be

settlers with such success that hardly a house is to be seen. None have ever been successfully tamed owing to the fact that the change of water incidental to removal to the neighbourhood of Lakon or Patalung (neighbouring towns) seems to affect their health and they do not long survive. Both men and animals are, so far as I have observed, very susceptible to a change in the water."

Mr. W. A. Graham, the author of "Siam," a comprehensive book on the whole of Siam, recently published in two volumes, also quotes from the above in volume I, page 72 of his book.

I have visited the country lying immediately to the north of the Inland Sea on two recent occasions and I made the following observations there, during my tours.

The country bordering the northern end of the Inland Sea is level land covered with grass and reeds. Eastwards towards the Gulf of Siam the country is thinly populated, whereas to the North-West, the plain ends in a swampy forest, the edge of which, seen in the distance, stands out very clearly. This northern area is quite uninhabited.

About 2 miles to the north of the Inland Sea there is a small ake called Talè Noi, more or less circular in shape with an approximate diameter of 4 miles; it is connected by a small river with the Inland Sea. It is very shallow and partly covered with weeds. On the plains and in the forest a herd of about 300 wild elephants are constantly roaming about. These animals wander about the plains, both by day and by night and are usually seen in small groups.

When I first visited Talè Noi last year I saw 7 or 8 elephants quite close to the small river between the two lakes. In June this year 1924 I counted about 40 animals scattered over the plains some of them quite close to the small river. The accompanying photograph was taken on this occasion from a distance of about 125 meters, approaching the herd through breast-high grass. All the elephants I observed were tuskless, but as regards their height, shape and colour I did not myself notice any difference from other wild elephants.

As far as I am aware, the strip of land, which separates the waters of the Gulf of Siam from those of the Inland Sea, has for generations been more or less under cultivation and is fairly populated and no elephants are found there; they are all confined to the uninhabited country immediately to the north of the Inland Sea.

At any rate, this is the state of affairs at present, and in this respect I must differ from certain remarks which were made by Mr. Warington Smyth in his original lecture on the subject. I was informed that repeated efforts had been made to tame these elephants, but the capture always resulted in the speedy death of the animals. The information tallies exactly with the information given by Mr. Warington Smyth and may be due to the reasons which he has given.

I also noticed that these elephants seem to have very little fear of man and took no notice whatever of the local people fishing along the banks of the small river.

It would be very interesting if some Museum or other scientific body could obtain permission from the Siamese Government to secure a male and female from this herd to determine definitely if this is a distinct species of elephant or not?

R. HAVMOLLER,
Agent, East Asiatic Company,
Singora, Southern Siam.

ROADS, BUILDINGS AND FORESTS IN BURMA

Forests hidden away in the inaccessible back of beyond are of little use to anybody, except for covering hills and preserving water and for providing nice pictures for landscape artists. When roads and buildings begin to approach them they rapidly become of great importance. Burma, the largest forest province in the Indian Empire, seems to be making progress in roads and buildings *Indian Engineering* has a leader on January 3rd on Buildings and Roads in Burma and points out that many new houses have been built including seventeen quarters for forest

officers. Pyinmana Forest School benefited in another direction by a new water-supply being provided by the Public Works Department. To those who have toured much in Burma, anything in the nature of progress in road-making is of the most vital interest Vast tracts of land, mainly forest, are inaccessible except by the roughest hill paths and quite recently (possibly at this moment) it was impossible to drive a car from Mandalay to Rangoon. *Indian Engineering* says:

"In the matter of communications, anyone who has read the excellent report of Mr. C. C. S. Clark on the road requirements of Burma knows how large a sum of money must be spent on the roads of the province if the communications are to be in a really satisfactory state. For the purposes of this report, Mr. Clark was placed on special duty and, a road engineer with long experience of Burma, he carried out his task exceedingly well. The circumstances of Burma were, as he pointed out, peculiar. The valleys of the province run north and south, and are separated by hills and jungles The old roads followed the valleys and for a long time there was no great need for inter-communication But as Burma developed, the demand for more roads and better roads continued to increase Mining and planting interests called for means of transport, motor locomotion came into use, and the old roads made and maintained on the cheap were a positive disgrace. The road surfaces were often deplorable, the old timber bridges were liable to be dangerous, and it was not the fault of the engineers, it was merely a matter of want of funds. With the funds placed at their disposal, the engineers did all that was possible, but the position was nevertheless unsatisfactory. Mr. Clark's scheme implied an expenditure of Rs. 4,60,38,670, which may give at first sight the idea of too extravagant proposals, but as a matter of fact the figure was not too high for the demands of Burma, and it was a pity that the money could not be made available. Since then the Department has had to do its best with the funds allotted year by year, and now that there is a Roads Board it is understood that the position is improved. During 1922-23, the expenditure was Rs. 58·94 lakhs on provincial Roads and Rs. 18·42 lakhs on local fund works. Of this outlay original

works absorbed Rs. 28·89 lakhs provincial, and Rs. 6·38 lakhs district, whilst Rs. 30·05 lakhs and Rs. 12·64 lakhs were spent on repairs of provincial and district roads, respectively. The upkeep of 2,234 miles of metalled and 9,600 miles of unmetalled roads cost Rs. 42·09 lakhs, an average of Rs. 354 per mile in the year. The original work done consisted mainly in improving the existing roads, by raising, widening, metalling, and in replacing worn-out timber bridges with structures of a more permanent character. Projects were also prepared for further improvements owing to the growing use of motor cars in all localities, and surveys were made for the construction of six new roads. Suitable metal has always been a difficulty in Burma, and reconnaissances have been made in three districts for quarries, and the quarries at Mokpalin in the Thatôn district were opened. It it said that these activities will result in the near future in the provision of the necessary metal for the Pegu and Rangoon areas. The administrative report gives a very good description of the operations of the Buildings and Roads Branch of the Department in the year concerned."

This sums up the position very well and forest officers more perhaps than any other of the inhabitants of Burma, know what the lack of roads really means. They visit tracts visited by no one else and they appreciate what loss of time and money is involved by the absence of roads. Every anna spent in making roads to the forests of Burma will come back.

IMPERIAL FORESTRY INSTITUTE.

The Imperial Forestry Institute at Oxford started work on October 13th, temporary accommodation having been provided in the School of Forestry building until arrangements can be completed for the erection of new buildings on another site. The Board of Governors of the Institute is now fully constituted and consists of the following :—

Lord Clinton, Forestry Commissioner (Chairman), The Vice-Chancellor of Oxford University, Mr J. Wells, M.A., Warden of Wadham College ; The President of Magdalen, Sir Herbert

Warren, K.C.V.O., M.A., Hon. D.C.L.; Professor W. G. S. Adams, Fellow of All Souls' College; Mr. R. L. Robinson, O.B.E., Forestry Commissioner; Major R. D. Furse, D.S.O., Colonial Office; Colonel G. L. Courthope, M.P., Empire Forestry Association; Professor R. S. Troup, C.I.E., M.A., D.Sc., Director.

The following staff has already been appointed: Director, Professor R. S. Troup, C.I.E., M.A., D.Sc.; Secretary, Mr. P. S. Spokes, B.Sc., M.A.; Lecturers, Economics of Forestry, Mr. W. E. Hiley, M.A.; Silviculture, Mr. H. G. Champion, M. A.; Mycology, Mr. W. R. Day, B.A., B.Sc.; Structure and Properties of Wood, Mr. L. Chalk, B.A. Other posts have yet to be filled. The Institute will, in addition, have the assistance of the following members of the staff of the School of Forestry: Forest Management, Mr. R. Bourne, M.A.; Surveying and Engineering, Mr. N. F. MacKenzie, Hon. M.A. The Forestry Commissioners have agreed to station at the Institute certain of their research officers In spite of the fact that the Institute is not yet fully organised and that sufficient time has not yet elapsed for the attendance of students from all parts of the Empire, nine students, deputed by the Colonial Office and the Forestry Commissioners, have begun special courses, and further students are expected to join during the next few months.

COOPER'S HILL WAR MEMORIAL PRIZE.

At the conclusion of the War the members of the Cooper's Hill Society subscribed towards providing a memorial to Cooper's Hill men who lost their lives in the War. The money subscribed was devoted to the endowment of a prize to be known as the "Cooper's Hill War Memorial Prize," to be awarded annually to members of the Institution of Civil Engineers and triennially in rotation to (*a*) the Institution of Electrical Engineers, (*b*) the School of Military Engineering, Chatham, (*c*) the School of Forestry, Oxford. It was agreed that in the case of the School of Forestry the prize should be awarded to the most meritorious student of the preceding three years. In making the award in

1924, the first year in which the prize goes to the Oxford School of Forestry, it was decided to include the four years 1920—1923 since the year 1920 was the first post-War year in which students completed the full course of training. The prize itself consists of a sum of money, a bronze medal and a parchment scroll, and the award is made by the Oxford Committee for Forestry.

On the present occasion the prize has been awarded to Mr. R. C. Marshall, who completed his course of training at the School of Forestry, Oxford, in 1920, and is now Conservator of Forests in Trinidad.

REVIEWS.

TIMBERS OF TROPICAL AMERICA.

TIMBERS OF TROPICAL AMERICA, by SAMUEL J. RECORD, M.A., F.E., Professor of Forest Products, Yale University, and CLAYTON D. MELL, B.A., M.F., Tropical Forester, pp. 1—610, Yale University Press, New Haven, U.S.A.; Humphrey Milford, London, and Oxford University Press, England, 1924. Price $10.

The Preface to this valuable contribution to literature dealing with the forests and timbers of tropical America, after briefly reviewing the basic factors governing the more intensive exploitation of tropical forests, goes on to state that "the most serious hindrance to the introduction of tropical hardwoods into new fields is the lack of information concerning them." Greater justification for taking up so arduous and difficult a task would be difficult to find. The preface is well worth perusal by Indian Foresters, as the condition of the Tropical American Forests must be very similar to those found in many parts of India, and therefore the problems of exploitation must n many cases be very similar. For instance, it is stated that the application of modern methods of extraction in mixed tropical forests are beset with difficulties. Then again, it is stated that "the tropical timber business of the future, however, will tend more towards the non-precious woods, etc.,"—a fact that some

people interested in Indian Hardwoods have not as yet fully realised. Stress is also laid on the importance of proper seasoning methods.

The work is divided into two parts; Part I describes the countries and the forests of Tropical America, comprising the West Indian Islands, Mexico and Central America and South America. This portion of the book is the work of Mr. Clayton D. Mell, who was formerly Assistant Dendrologist in the U. S. Forest Service, then in the timber business, and since then employed on reconnaissance work in the countries and forests which he describes. He is therefore well qualified to deal with the subject. Part II, describes the trees and their woods, and is in the main the work of Mr. Samuel J. Record, the well-known Professor of Forest Products and Wood Technology at Yale University.

Part I opens with short sketches of the local and economic conditions prevailing in each of the larger islands of the West Indian Group, and the subject matter dealt with shows the intimate knowledge of these countries possessed by the writer. The salient point brought out in this part of the book is the fact that these islands import far more timber than they export, thus Jamaica imports annually over a million dollars worth of lumber from the U. S. A. and Canada, while the exports are considerably smaller and rapidly dropping year by year. Cuba exports $\frac{3}{4}$ to $1\frac{1}{2}$ million dollars worth of hardwoods and imports over $\frac{1}{2}$ billion broad feet of spruce and silver fir, besides manufactured woods. The sketches are interesting reading and useful for reference.

The next area dealt with is Mexico and Central America, comprising seven Spanish American Republics and the British Colony of Honduras. The description of the types of forests met with and the economic conditions prevailing in Mexico, British Honduras, Guatemala, Honduras, Salvador, Nicaragua, Costa Rica and Panama are more fully dealt within those of the West Indies, and rightly so, as these countries are far richer in forest wealth and cover far greater areas. The illustrations in this part of the work are excellent, depicting types of forest, forest working and forest life. The reader will at once be struck by the

enormous wealth of timber available from these areas, not to mention minor forest products, including mangrove tan-barks from the deep fringe of mangrove forests round the Gulf of Mexico. The portion on South America, is the more detailed of three, special prominence being given to the forests of Brazil, which are the most extensive and important. This section opens with a short geographical description of the continent, which is divided into three natural regions. Then follows useful sketches on the economic conditions prevailing in the thirteen most important countries of the continent, together with more detailed accounts of their forests.

Part II comprises roughly 7/8th of the whole book, and deals with many of the timbers found in the forests of Tropical America. The classification is according to Engler and Gilg (1912).

Seventy-five families are dealt with, each family is introduced by stating its size, distribution, and importance from an economic standpoint. Then follows a consideration of the more important genera and species. If a criticism may be made, it is that to the general description of the species, more might have been added as to quantities of timber available, the difficulty or otherwise of extraction and as to present or prospective uses of the timber.

In describing the wood, the latin name is given first and also the trade name, which are followed by all the available names of the wood in the different languages. Next the "General properties" of the timber are dealt with, such as colour, taste, odour, specific gravity, hardness, strength, durability and working qualities. The anatomical structure is then described, dealing first with the gross and then with the minute anatomy of each timber. The amount of information given varies, more detailed information having been collected for the economically more valuable timbers, than for those of less value.

A point of very considerable interest to us in India, is the reproduction of the microphotographs which find place in this book, as such work is now being undertaken with the more important timbers of India. These illustrations are at x 50; it is

questionable whether pocket lens size would not have been more useful, as high power microphotographs are more applicable to research work than to the forester or commercial man, which this valuable publication will primarily interest. The other illustrations, of types of trees and forests, views of the countries described, lumbering, etc., are excellent.

The whole work is one of extreme value, and can safely be classed as a standard work, laying the basis to further development of the magnificent timber resources of the South American Continent. The authors are to be congratulated on the successful completion of their herculean task, which can but be productive of useful results.

R. S. P.

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THE GOALPARA FOREST TRAMWAY.

Accounts appeared in the *Indian Forester* of the Goalpara Forest Tramway, Assam, in the issues of September and October 1906 and December 1915, and it may interest your readers to learn of the progress since made on this project in the last three years from January 1922 to December 1924. At the risk of recapitulation it may be stated that the line was first installed in 1906 with the object of supplying water to the waterless *sal* tracts lying under the Himalayas north of Kochugaon. At that remote period there were few forest villages and carts were scarce so that the trucks were subsequently used for bringing down timber. The trucks had to be pushed by hand and the work was extremely laborious so that in 1912 a locomotive of German make was purchased to run on the lines laid for hand traction. Most of the rails were of 14 lb. gauge, a few miles only being of 18 lb. gauge. The logs were tipped out on to the banks of a small meandering stream, called the Garufela, on which a boat had to cover sixty miles to achieve a distance of 20 miles in a direct line. *Sal* logs were tied on to boats some of which are floated right down to the Brahmaputra, other logs being taken out of a railway station (Sapatgram) *en route* where the Eastern Bengal Railway crosses the Garufela River. The Garufela could only be used when it was not in flood or at low water so that transport was limited to a few months of the year making the floating by boat very expensive and precarious.

In 1920 the Garufela started to break its banks and flow into another channel. This breach was closed up but another breach occurred in 1921 which resulted in a fresh channel being opened out. As the latter cut down its tree covered banks the presence of snags prevented its use as a floating channel. This brought matters to a climax and it was decided that the southern end of the existing line at Kochugaon *must* be continued to one or other of the four stations on the Eastern Bengal Railway. Projects of the different routes were made by a Railway Engineer. These were from Kochugaon to the following Railway stations :—

(*a*) Kokrajhar—Distance 26 miles.—Estimated cost Rs. 4,32,000 with a big river crossing which was likely to give considerable trouble in future years.

(*b*) Tipkai—Distance 21 miles.—Estimated cost Rs. 3,54,358. The most westerly and probably the best route as regards bridges and high ground.

(*c*) Fakiragram—Distance 16¾ miles.—Estimated cost Rs. 2,90,850. This route was finally adopted.

(*d*) Sapatgram.—The direct route passing over merely country and innumerable streams put this out of the running and no estimate as to length or cost was made. It might perhaps have been possible to keep to high ground all the way by making a detour to the west.

After completion of the acquisition proceedings, work was started on the Kochugaon-Fakiragram scheme in January 1923. In the short period before the rains broke 15 miles of embankment were constructed, a temporary line laid down and 17 permanent and 30 temporary bridges built. The problem of bringing the sleepers from the north end at Kochugaon so as to co-operate with the rails delivered at Fakiragram on the south without using carts being solved with some ingenuity by the Divisional Forest Officer.

The rainy season of 1923 brought all earth work to a close, but the carriage of bridge materials continued and a certain amount of pile driving was done when opportunity offered.

Work was continued with energy as soon as the rains stopped and the remaining earth work completed. In December 1923 a motor trolley was derailed unfortunately on a bridge, the Divisional Forest Officer, Mr. Simeon, dying from the effects of a broken spine. The work was continued with undiminished zeal by his successor Mr. Smith and the line opened to traffic by March 1924; a few trains being run with difficulty over the new bank which had not then consolidated. In July 1924 heavy rain flooded the whole of the Assam valley causing several bad washouts on the newly constructed embankments. A new and somewhat heavier engine having been purchased it was also found desirable to replace the bridge girders on two of the larger streams, *i.e.*, the Hel and the Longa, by steel girders; the wooden girders were taken out and utilised on other bridges to which extra spans were added to replace abutments which had disappeared and to allow of an increase in waterway. The floods did not really delay matters as much as might have been expected The tramline was again open to traffic in November 1924 and a train has been running daily except on Sundays ever since. It is necessary to raise the bank above normal flood level at certain spots and levelling is still going on so as to make the permanent way as perfect as possible. Derailments of logs which were common at first are now becoming scarce.

It is interesting to look back on the estimates made by the Railway Engineer and although work is not yet *quite* complete the following comparisons are approximately correct :—

(*a*) Preliminary expenses—Estimate Rs. 10,850. Actuals Rs. 1,686. No remarks.

(*b*) Acquisition of land and compensation to villagers. Estimate Rs. 11,843. Actuals Rs. 15,853 due to the generosity of the Deputy Collector appointed to work out the damage.

(*c*) Formation—Earth Work. Estimate Rs. 50,563. Actuals Rs. 32,766. More earth work however is still necessary.

Bridge Work.—The Railway Engineer estimated for 22 bridges to cost Rs. 57,040. It has been found necessary to

construct 47 bridges and culverts some of which were necessary to allow water taken off stream by channels at points north of the lines to irrigate rice fields on the south side. The cost to date is Rs. 37,989.

The following bridges and culverts were constructed :—

1 of 8	spans of	30 feet	=	240 feet.
1 of 5	,,	30 ,,	=	150 ,,
1 of 4	,,	25 ,,	=	100 ,,
1 of 3	,,	25 ,,	=	75 ,,
1 of 2	,,	25 ,,	=	50 ,,
1 of 8	,,	15 ,,	=	120 ,,
1 of 6	,,	12 ,,	=	72 ,,
3 of 2	,,	20 ,,	=	(3 × 40) feet.
5 of 1	,,	25 ,,	=	(5 × 25) ,,
8 of 1	,,	20 ,,	=	(8 × 20) ,,

24 of spans varying from 8 to 18 feet.

The type of bridge used consists of four girders on four rows of piles the rails running on cross beams and immediately over the two centre girders.

Permanent Way.—Estimate Rs. 1,24,708. Actuals Rs. 1,63,063.

Permanent way especially the rails were under-estimated and could not be obtained at the price entered in the estimates. The 14 lb. rails first used cut grooves in the engine wheels owing to the narrowness of the tread and 24 lb. rails were used for the new part of the line. Some 40,000 sleepers were used on the line.

Stations and buildings —Estimate Rs, 2,521. The estimate for buildings is somewhat low as a rest house for officers will be necessary as well as a Depôt Office and quarters for the Depôt Officers. The rest house is not built yet as more important work had to be taken in hand first.

Rolling Stock.—Estimate Rs. 18,500. This again is too low—a new loco was purchased at a cost of Rs. 15,000 and many more trucks are still required. Cost of Locomotive and Rolling Stock = Rs. 22,173. There are now two locomotives, one of four ton

bought in 1912—a six-wheeler of 20 H. P., and one of six tons in 1923—a four-wheeler of 30 H. P. The latter will naturally carry a heavier load but is only suitable for the new part of the line laid with 24 lb. gauge rails. It is heavier and has all its weight on four points instead of six. The old one is used on the old portion of the line, another 30 H. P. locomotive has been sanctioned and with more rolling stock the capacity of the line can be increased by a good deal more than one-third.

Maintenance and running expenses are estimated at Rs. 20,000 a year: with 250 working days at 600 cubic feet per day the outturn with two engines is expected to be about 160,000 cubic feet in the year which amounts to annas two a cubic foot. The light railway will also be useful for hauling tanks of water into the *Bhabar* tract for sawyers, loggers and cartmen. The interest on the loan of approximately three lakhs taken with depreciation may be put down at 20 per cent. amounting to Rs. 60,000 which works out to about six annas, so that eight annas may be allowed for interest, depreciation and maintenance. The present market price of *sal* averages about Re. 1-4-0 per c.ft. in the log after deducting cost of logging and transport to the tramline. Before the present extension was made *sal* trees were sold at a price which worked out to about six annas per cubic foot. The difference of value can therefore be placed at annas fourteen per c.ft. If the eight annas shown above for interest, depreciation and maintenance is deducted there remains a difference of six annas per c.ft. which should cover the risk of a fall in prices and extra expenditure required for extensions, etc.

ANOGEISSUS ACUMINATA (YON).

REPORT ON GREEN MATERIAL TESTED UNDER PROJECT No. 1.

1. *Material.*—The material for the tests discussed in this report was supplied by the Utilization Conservator, Rangoon, Burma. Six logs from freshly felled trees were received, five for test under Project No. 1, and the sixth for examination to

determine its fitness for use as railway sleepers. The former was placed in the log pond on receipt near the end of August 1924, and the latter was handed over to the Wood Preservation Section. Full descriptions of the logs were supplied by the collector who procured the material, and botanical specimens from each tree were submitted to the Forest Botanist for identification. The following is an extract from the report submitted by that Officer :—

"Specimens Nos. 1, 5, 6, 15 and 22 are *Anogeissus acuminata* Wall., as understood by Brandis and others. They are the form *Anogeissus phillyraefolia*, Hear, and Muell. Arg., which is treated in Lace's list of trees and shrubs of Burma (perhaps correctly) as a separate species from *Anogeissus acuminata*." Nos. 1, 5, 6, 15 and 22 are the specimens from the trees which furnished the logs for the tests dealt with in this report. The writer also prepared microscopic sections from each of the five logs and found them to be identical with material from the Gamble type specimen of *Anogeissus acuminata* in the museum of the Forest Research Institute.

2. *Testing.*—The Testing Laboratory was able to take up this species by the end of October 1924, and the logs were cut up into test specimens according to the instructions laid down for Project No. 1. (Project No. 1, Mechanical, Physical and Structural Properties of Wood grown in India, Tests on Small Clear Specimens, Scheme of Operation No. 1.) This provided material for a full series of tests on green specimens by standard methods, and of corresponding material for later tests on air seasoned and on kiln seasoned specimens. The pieces for testing green were at once finished into test specimens and taken in hand by the testing staff, and the two lots of pieces for testing seasoned were measured, weighed, and properly stored to be dealt with later.

As the Utilization Conservator, Rangoon, had asked especially for information as to the suitability of *Anogeissus acuminata* for hammer handles and for oil well sucker rods, and as the logs were fortunately large enough to furnish a fair quantity of good wood after the routine test specimens had been cut as

mentioned above, as many as possible rough blanks for manufacture into sucker rod ends and hammer handles were cut and stored for seasoning.

The green material was tested in static bending, impact bending, compression along the grain, compression at right angles to the grain, hardness on end, radial, and tangential surfaces, shear along the grain in radial and in tangential planes, and in tension across the grain. The nature of these tests and of the data obtained from each is described in the "Project No. 1" mentioned above. The tests of green specimens were finished on November 24th, and the computation of test results was completed on December 31st, 1924.

3. *Tables of Results.* – A table of test results is inserted here for reference. This table presents the strength values for green *Anogeissus acuminata* from Burma, green *Anogeissus latifolia* from Madras, and green *Tectona grandis* from Burma, the last two being included for purposes of comparison. The values for green teak have been chosen because tests have shown that the strength of seasoned teak is the same whether taken from green or from girdled trees, and by using green teak for this table a perfectly fair comparison can be made, all three species having been tested under identical conditions.

Two lines of values are given for each species. The first presents the actual average of test results and the second the same values expressed as percentages of the corresponding figures for teak. The average strength values presented in this table for *Anogeissus acuminata* are based on the following number of Tests :–

(1) for static bending, 60 tests,
(2) for impact bending, 35 tests,
(3) for compression parallel to grain, 115 tests,
(4) for compression perpendicular to grain, 31 tests,
(5) for hardness, 84 tests,
(6) for shear along the grain, 30 tests,
(7) for tension perpendicular to grain, 30 tests.

Specific Gravity determinations were made on all test pieces except those for shear and tension and ten other specimens

saved for making photographic records, and the moisture content was determined for every specimen except, as before, those saved for photograph. Shrinkage values cannot be given till the seasoned material has been tested.

4. *Inferences from the Table.*—Considering first the general inferences that can be drawn from the table of test results, each strength function determined by test is expressed as a percentage of the corresponding value for teak. These percentages are worked out exactly as they are found from the average results of all the tests taken from five logs of each species, but in the following discussion the exact percentages will not be used, because the complex organic structure of wood introduces too many variables to justify the use of exact ratios when comparing various species. Therefore the different characteristics will be taken up in turn using approximate ratios.

First as a beam subjected to static loading, ***Anogeissus acuminata*** is about 15% stronger (columns 8 and 9), stiffer (column 10), and tougher (column 11) than teak. If used as a beam subject to impact or sudden stresses it is about 20% stronger (columns 12 and 13), about 35% stiffer (column 14) and slightly tougher (column 15) than teak. When called upon to bear impression loads along the grain, as in the case of short struts and columns its strength and stiffness are about 15% above those of teak (columns 16, 17 and 18). When subjected to crushing across the grain, as in the case of railway sleepers and floor beams, it can carry at least 40% more load than teak (column 19). The hardness of its side surface is from 60% to 70% greater than that of teak (columns 20 and 21), while on the end grain it is practically double as hard as teak (column 22). Its resistances to shearing along the grain are 30% and 70% greater than teak on radial and on tangential planes respectively (columns 23 and 24), and its resistance to splitting is about 40% greater than that of teak (columns 25 and 26).

Considering next the special uses referred to above, namely, as hammer handles and as sucker rods, it is necessary as a preliminary study to examine only those strength characteristics which affect the usefulness of the wood for the purpose in view.

The following table is of use in the preliminary examination of *Anogeissus acuminata* as a hammer handle wood :—

	Specific Gravity.	Static Bending.				Impact Bending.		
		F.S. at E.L.	M. of R.	M. of E.	Work to E.L.	F.S. at E.L.	Max Drop.	Work to E.L.
	1	2	3	4	5	6	7	8
A. acuminata ...	·71	8,015	13,140	1,914	1·90	20,050	44″	8·4
Fraxinus americana	·52	4,900	9,100	1,350	1·03	11,700	36″	5·00
Hickoria glabra ...	66	6,200	11,700	1,650	·34	16,900	89″	8·80

It would appear from these results that even without further tests *Anogeissus acuminata* can be recommended for use as hammer handles. It is superior in every respect to ash and except for maximum drop and work to elastic limit in the impact bending tests, is superior to the best of the imported hickories. Maximum drop, it should be explained, is the height through which it is necessary for a 50 lb. weight to fall on to a beam of 2″ by 2″ cross section supported on a 28″ span to produce complete fracture. As it is a characteristic of hickory that the difference between the height of drop necessary to produce the first break and that necessary completely to fracture the wood is much greater than in the case of *Anogeissus acuminata*, and as a hammer handle is generally considered to be useless after the first break has occurred, the fact that the maximum drop for hickory is double that for *Anogeissus acuminata* does not necessarily mean that the former will make a better handle. The only respect in which *Yon* may be inferior is that of weight. It is seen from column 1 that it is 42 per cent. heavier than ash, and 12 per cent. heavier than hickory, but these differences, it is thought, will not prove to be

any real objection to its use for tool handles. It is amply clear from these results that suitability tests, that is tests of made up handles, are well worth making, and this work will be proceeded with as soon as the wood is sufficiently seasoned.

The essential strength values for a wood that is to be used for oil well sucker rods are its compressive strength along the grain and its end hardness, because, unless it is sufficiently strong in these respects, it allows excessive bending of the rivets in the coupling sockets and consequent breakage of the rivets and parting of the rods at joints. The standard wood for sucker rods is American hickory, and two of the imported hickories are compared with *Yon* in the following table:—

...	*Compression along the grain*		End Hardness
	F. S at E. L	Max. Crushing Strength.	
A. acuminata	4,385	6,570	1,81[illegible]
Hickoria glabra ...	3,950	4,810	Not tested.
Hickoria pecan	3,[illegible]4[illegible]	3,9[illegible]0	1,270

It is evident from this that *Yon* is a most promising wood for oil well sucker rods, and, as in the case of hammer handles, arrangements are being made to proceed with suitability tests as soon as possible. These will comprise single rivet bearing tests, and tests of standard sucker rod ends both under steady tension and under repeated loading up to stresses 50 per cent. in excess of what they may be called upon to carry in practice.

5. *Conclusions.*—The final report on this, as on any timber cannot be made until after the completion of tests on seasoned material and of the suitability tests, but based on the results of that part of the work already completed. The following conclusions may safely be presented :—

(1) *Anogeissus acuminata* (Yon) is 25 per cent. heavier than teak.

(2) In general strength characteristics it is about 15 per cent. stronger than teak, though in some respects it is much stronger than that timber.

(3) It will probably make extremely good hammer, axe, and other tool handles. This matter will be fully reported on at a later date.

(4) It will probably make better sucker rods for oil wells than American hickory. This matter also will be taken up in a later report.

(5) It has strength values which, unless seasoning or preservative treating difficulties be met with, fit it to make one of the best sleeper woods in the world. All the properties governing its usefulness for sleepers are being studied and will be presented later in a joint report by the Testing, the Seasoning and the Wood Preservation Sections.

L. N. SEAMAN,
Officer in Charge,
Timber Testing Section.

Table of Test Results.

Species.	Locality.	Seasoning.	Sp. Gr. (oven dry).	Moist content.	Wt. as tested in lbs. per c. ft	Shrinkage.		Static Bending.				Impact Bending.			
						Radial	Tangl.	F. S. at E. L.	M. of R.	M. of E in 1000's lbs.	Work to E. L.	F. S. at E. L.	Max. drop.	M. of E. in 1000's lbs.	Work to E. L.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Tectona grandis ...	Burma	Green	0·591	49·9%	55	2·1 %	3·3 %	6,935	11,46[illegible]	[illegible],640	1·65	17,04[illegible]	36″	2,070	7·83
			100					100	10[illegible]	100	100	10[illegible]	10[illegible]	100	100
Anogeissus latifolia (Bakli)	Madras	,,	0·828	31·5%	68	4·2 %	7·2 %	6,765	12,755	1,737	1·53	18,305	57″	2,223	8·64
Anogeissus latifolia strength values expressed as % of Teak.			140					98	111	106	93	107	1[illegible]8	107	110
Anogeissus acuminata (Yon)	Burma	,,	0·739	34·8%	62	...	...	8,015	13,140	1,914	1·90	[illegible]	44″	2,773	8·14
Anogeissus acuminata strength values expressed as % of Teak.			125					116	115	117	115	118	122	134	104

Species.	Comp. parallel to grain.			Comp. perp. to grain	Hardness.			Shear.		Tension.	
	F. S. at E. L	Max. Cr. Str	M. of E. in 1000's lbs.	F. S. at E. L	Radial.	Tangl.	End.	Radial	Tangl.	Radial.	Tangl.
	17	18	19	20	21	22	23	24	25	26	27
Tectona grandis ...	3,815	5,710	1,735	930	980	960	910	990	1,080	515	685
	100	100	100	100	100	100	100	100	100	100	100
Anogeissus latifolia (Bakli) ...	3,460	5,730	1,735	1,575	1,950	1,965	2,055	1,455	1,665	645	790
Anogeissus latifolia strength values expressed as % of Teak.	91	100	10	169	199	205	226	147	154	125	115
Anogeissus acuminata (Yon) ..	4,385	6,570	1,959	1,325	1,670	1,575	1,815	1,295	1,850	710	980
Anogeissus acuminata strength values expressed as % of Teak.	115	115	113	142	170	164	199	131	171	138	143

EPICORMIC BRANCHES IN *SAL*.

If they had been asked some years ago what caused epicormic branches in *sal* most foresters would probably have replied, rather loosely, that it was a sudden access of light to the bole. Questioned more closely some might have said that the crown had lost the power of easy response and the dormant buds therefore developed to take advantage of increased light, others would have said that the exposure of the bole caused the production of epicormic branches which prevented the complete nourishment of the crown and caused stag-headedness or at any rate unhealthiness. Both would have connected the development of the epicormic branches with exposure of the bole to light but some would have said this development was the *cause* of an unhealthy crown others that it was the *effect*.

Later it was noticed that the boles of many trees in well stocked closed forests of certain species were covered with curious rosettes of somewhat weak epicormic branches. These trees usually had obviously poor crowns if they were not actually stag-headed. I believe this was first brought conspicuously to public notice by Mr. Bourne who advanced the theory that it was crown construction largely (but also any other cause of crown unhealthiness), which was responsible for epicormic branches in closed teak forests. The idea was quickly taken up by other silviculturists as an explanation of the same phenomenon in *sal* forests and some of these went so far as to convey the impression that over density was the chief cause and that the isolation of *sal* trees would never cause the production of epicormic branches.

I have had one or two areas under observation for some years now and, though I am not prepared to advance any hard and fast rule, I propose to record my observations. Perhaps others who know the *sal* will record theirs. One area is now 10 years old from the time of clear felling. I have seen it since it was 2 years old. At present it contains a large number of stems which I think most observers would describe as covered with epicormic branches. But actually they did not develop because

Fig. 1. A *sal* area just after felling in 1917. Forty of the best stems left per acre. Note the crowns and the boles many of which have weak rosettes of epicormic branches and also the clean stem in the foreground in the right. Campierganj, Gorakhpur Division.

[Illustrating article on p. 160]

Fig. 2. A dry Nursery in Santgal in S. D. Kanara (Bombay) in 1922. Contains over 60,000 *strong healthy plants.*

[Illustrating article on p. 163]

more light had reached the boles nor because the crowns were unhealthy. They have been present always.

I am inclined to believe that a large number of the trees in closed *sal* forests have rosettes of rather feeble epicormic branches simply because of the persistence of these original branches which developed before the trees became constricted. That is I think the *persistence* may be due partly to the present lack of foliage in the crown but that the *production* is not caused always by crown unhealthiness or constriction.

The next point is what happens when *sal* trees which have grown up in closed forests are placed in an isolated position, *e.g.* seedbearers or standards over coppice.

The illustration (Plate 10, fig. 1) shows a plot where the trees were reduced to 40 per acre in 1917. The second photograph (Plate 11, fig. 1) was taken in November 1924. I regret it is a poor photograph but it shows sufficiently I think the enormous production of epicormic branches. The mass of foliage *is* epicormic branches not coppice shoots nor undergrowth. This had actually happened by 1921 and the branches are 6 feet and 8 feet long and three inches and more in girth. The one tree conspicuously without branches had always been isolated on the edge of a road. The area is poor III quality but the standards left were the best which could be found and the first photograph shows that the crowns were much like many of our *sal* and the boles as clean.

I have also examined a coupe of the Pilibhit Division where a system of coppice with standards is prescribed and I found that four years after felling the majority of the standards were covered in epicormic branches three or four feet long. Unfortunately I was only able to examine one coupe of that age. I am told other coupes have clean boles.

I find also near Dehra Dun that standards of *sal* are commonly covered with epicormic branches.

I consider therefore that the access of light on the boles of our *present sal* crops is liable to lead to a great development of epicormic branches. Future trees grown under more enlightened ideas on thinnings may act differently.

Fig. 1. The same area as illustrated in Plate 10, fig. 1 in 1924. Note the mass of epicormic branches on most stems though the one on the right is still clear. No coppice shoots of *sal* have spring up as the stools were rather too old and there was no suppressed regeneration nor seedlings. There are many seedlings now among the light grass.

[Illustrating article p. 160]

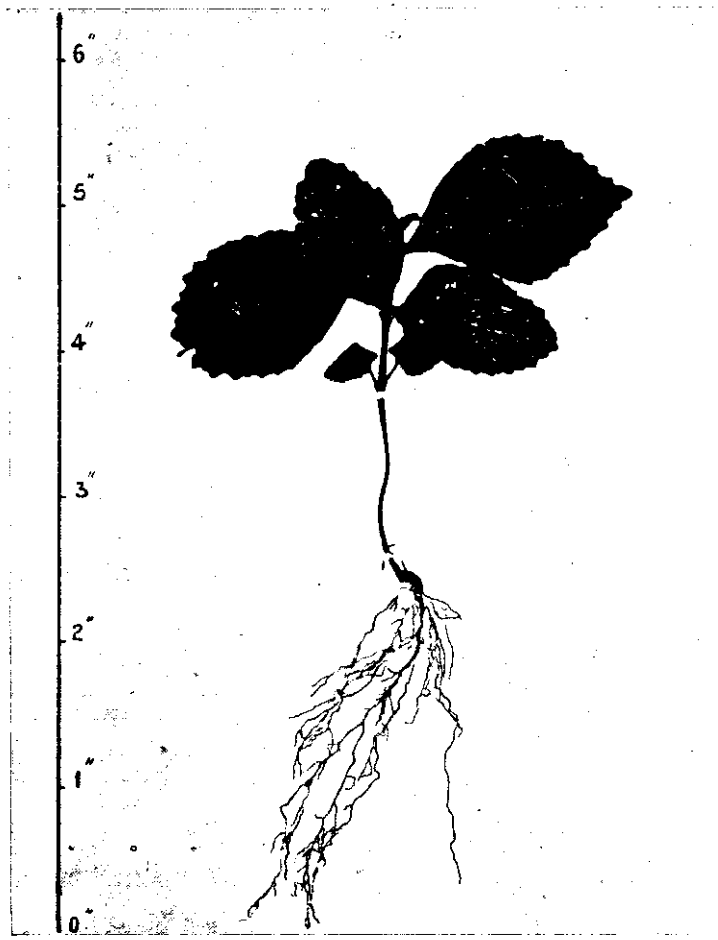

Fig. 2. Type of plant that thrives best on little Circular Mounds about 15" diameter and 9" height. Grows up to 24" height with great big leaves by the end of the 1st rains.
2 months' old plant.

[Illustrating article on p. 163]

In 1922 I wrote in the *Indian Forester* that in a plot with 52 standards of an average of 9·4 inches diameter left over 12 year old coppice that the coppice had suffered badly from suppression.

On page 166 of *Practical Forest Management* I see that in the Pilibhit system the maximum number for standards of between 8" and 10" diameter left between the 5th and 10th year is roughly 67 per acre and after the 10th year roughly 55 per acre. The plot of mine therefore with 52 standards at 12 years of 9·4 diameter is comparable to this and it appears that much suppression will take place if epicormic branches develop. Lower it says the number of standards to be left to the end of the rotation will be 20 to 40 so that this compares with the other plot.

It seems now that added to suppression of some coppice many of the standards produced are likely to be covered with epicormic branches six to eight feet in length and three inches girth or more.

A few years ago the system of coppice with standards for *sal* did not find favour with many people and it appears now that it is being revived Where there is such serious frost danger as in Pilibhit that may well be the ruling factor in the management and coppice with standards may have been prescribed *faute de minex* but in reading various reports I have formed the opinion, perhaps wrongly, that the system is being recommended as suitable *per se* among our present crops.

I should therefore be interested to know what others think of the matter if they will tell me. If the standards do cause suppression and if they themselves are likely to be covered with epicormic branches will this not reduce their sale price as timber.

Is this system one to recommend as a system with *existing* crops except to overcome some severe greater evil than itself—like severe frost ?

The girth increment caused by the epicormic branches is enormous some $6\frac{1}{2}$ inches in five years on a poor III quality area or a basal area increment of $8\frac{1}{2}$ per cent. per annum.

If anyone can produce any facts or observations to settle this point it would help matters forward. I had certainly con-

sidered coppice with standards as poor system for the *sal* as exists at present but I am told that it is not the system but the silviculture in carrying it out which is at fault.

S. HOWARD, I.F.S.

SOME METHODS FOR SECURING THE GERMINATION OF TEAK SEED.

The one great problem for the forest officer engaged in the work of teak regeneration is to secure full and rapid germination of seed in order to restock the cleared areas in the first year after burning, which is essential for minimising expenses and for other important reasons. Teak seed is notoriously slow in germinating powers, as it has a very hard shell and a thick felty upper coating enveloped in a calyx bag, all of which render the seed impervious to moisture conditions for a long period.

Various methods have, from time to time, been advocated for hastening the germination of the seed of which the following few may be quoted, *viz.*—

- (*i*) Scorching the seed in a light running fire of dry leaves or grass suggested probably by the idea that in burnt forests the seed is found to germinate profusely in nature.
- (*ii*) Immersion of the seed in hot water for a few hours.
- (*iii*) Immersion in cold water for a number of days.
- (*iv*) Soaking the seed in cold water for a few hours and then drying it for a day and repeating the operation for a given period, which may be called "alternate soaking and baking."
- (*v*) Burying the seed for a certain period. These two (*iv* and *v*) are the latest Burma methods.
- (*vi*) Dipping it in a mixture of cow-dung and water for a week (latest Cochin method).

None of these methods seem to be indicated by the rules of nature. Let me discuss these several methods one by one.

(*i*) *Scorching the seed.*—It is true that in burnt areas more new seedlings are seen after a fire than in unburnt

areas. This is only what is apparent to a casual observer. But very few have watched and seen. Closer observation will reveal that in the burnt areas it is the old seed that sprouts up and not the seed that is on the surface and that gets scorched by the fire. This is very visible in the case of semi-clayey soils of the teak pole areas in the southern parts of Belgaum and north part of N. D. Kanara, where after a goodly downpour of the mango showers in April and May the surface soil is rent into small fissures through which the plumule of the young plant is slowly making its way up. This young stem is very delicate in conditions of excessive moisture. In the unburnt areas and where drainage is good, this very young watery stem has nothing to contend against and so grows up. In the unburnt areas also the same process of germination goes on, but owing to a surface choked with leaves and grass, the young plants, though they come up from old seed in abundance, yet cannot struggle against the very wet conditions presented by the leaves and grass and so, many of them rot down. It does not however follow that fire is always welcome or necessary in the teak forests to hasten germination and to encourage the propagation of teak. As the saying goes, fire is a good servant but a bad master very occasional or controlled fires may be good in a way for certain reasons, but if these are allowed without let or hindrance what progress there be in the growth of vegetation? The result will merely be that seedlings will each year come into existence and be repeatedly burnt back. Damage to older stems will also be in the same proportion. I regret this short digression. The point I wish to bring out is, that although the sprouting of the old seed is the same in the burnt as well as the unburnt areas yet it is merely more conspicuous in the former than in the latter where the seedlings cannot thrive.

It was this observation which helped the Department a good deal in starting the method of "cultivation of natural teak seedlings" in the coupes of the teak pôle areas of Kanara. There in the coupes just felled the old seed used to germinate in abundance each year and as inevitably died down owing to too much moisture and choking. In 1913 this was found out, artificial assistance to such seedlings was brought to bear and thousands of natural seedlings were permanently saved. All this would show that scorchiug the seed is not necessary at all.

(*ii*) *Immersing the seed in hot water.*—There is nothing gained by this method. On the other hand there is every probability of the seed germ being spoiled. The method also does not lend itself to large scale operations.

(*iii*) *Immersing the seed in cold water for a number of days*—This may be successful to some extent but can hardly be adopted on any considerable scale and there is the risk of overdipping and ruining the seed.

(*iv*) & (*v*) *The two Burma methods.*—These are somewhat nearer to natural ways, but are troublesome and unlikely to give such good results as the method described in these pages which is called "weathering the seed." It is difficult to get the proper amount of soaking and baking and it is also difficult to obtain the exact treatment in the hands of all sorts of subordinates.

(*vi* *The Cochin Method.*—This may be possible with a handful of seed.

What is thought to be by far the most practical method experimented with recently in Kanara is the subjection of the seed to natural climatic conditions from the moment the seed is collected till it is sown a year after. This method seems likely to revolutionize the whole teak planting work. *In nature the seed never escapes the six months' period of rain.* In Kanara there is a rainfall of about 80 inches in the teak pole area and probably over 150 inches in the high forests and on the coastal tract.

Seed exposed to this rainfall throughout the rainy season gave cent. per cent. success during the last two years. The seed was not kept in the sheds. From the moment it was collected it was spread out in the sun and dew on a raised hard surface, sheet rock was selected wherever this was available. When the rainy season started the seed was left there, care being taken only that the rain water was effectively drained off. It remained there till the whole period of torrential rainfall was over (in the months of June, July and August there is a deluge of rain and as much as 15 inches may be recorded in a day—of course this is abnormal—but 4 to 6 inches is quite usual), and up till the end of December. The heaps were frequently stirred up bringing the bottom layers to the surface and *vice versa*. During this exposure a few seed, two to three per cent. germinated, but these were pricked out to dry nursery beds. When the seed was perfectly dry in December it was collected and sifted and sorted—the best and the next best being taken out separately. These were packed in gunny bags (better still in bundles of dry hay) and were kept in a cool airy dry and shady place. The sowing of this seed was carried out towards the end of May and even in the 1st week of June direct in the regeneration area and 90 per cent. germination was obtained, resulting in very fine healthy seedlings which in some cases attained a height of 2 feet by the end of the first rains. About 80 to 90 per cent. of such seedlings were strong and healthy at the end of the next hot weather where they were not destroyed by wild animals such as bison, sambhar or porcupine.

This method should enable the planter to have recourse to "direct sowing" practically entirely and to dispense with the costly nursery system, pricking out, transplanting and the difficulties of labour and heavy expense attendant thereon.

One great precaution necessary during the process of treating the seed in this manner is to see that rats do not eat the seed. They are *partial to it* and having once discovered the heap they do not stop until the whole stock is cleared away. To prevent this, good wire netting is recommended around the place where the seed is stored.

Seed treated in this manner is called "*Weathered seed*" in Kanara, as it is, from collection to storage, subjected to the full rigour of the seasons.

Having described the method of treating the seed I offer a few hints on sowing it as the results to be obtained from that seed would depend to a large extent on the manner of sowing adopted as well.

A thorough burning of all refuse is recognised as necessary for the success of a teak plantation and it is taken for granted that this is first obtained. Then line and peg out the required spacings—6′ × 6′ or 8′ × 8′, etc. Break the soil with an ordinary pickaxe rather deeply, put in 2 or 3 of the best seed and 3 or 4 of the next best*. Cover with the loosened earth and trample on it so that the seed may not be displaced when the rain comes down. Do this towards the middle of May or even in the first week of June if your burning is not ready in time, but at any rate before the rains break. A week after the regular monsoon begins, *i.e.,* about the 2nd or 3rd week of June all the seed will sprout. The first outbreak of the rains seems specially favourable to wholesale germination of the seed. Retain all these young plants in situ till about the middle of July by which time they will grow up to 3″ to 4″ with 2 to 3 sets of leaves leaving the cotyledonary leaves, of course. Then when the sky is steadily dark and cloudy and the sun does not shine for days and days in July and when the weather is moist and rainy and everything is favourable, *leaving one to a stake* transplant the excess seedlings wherever the seed has failed owing to such reasons as washing out on sloping ground, etc. This planting out, should be done on little circular mounds of about 12″ to 15″ diameter and 9″ height the soil sloping outwards. The young seedlings (see figure 2, plate 11) thrive best on such mounds, do not suffer from excessive damp (which condition should very carefully be avoided in the case of these young plants) and do not come into direct contact with seeds—the scraping of the surrounding soil

*An area spaced 6′ × 6′ holds 1,200 pegs per acre. 1 200 × 4 = 4,800 or say 5,000 seed. 1 lb of weathered seed gives 1,600 to 1,800. Hence 3 lbs. of weathered seed will suffice for one acre. *The fresh seed loses about ¼ of its weight in weathering.*

destroying all seeds of weeds. Such seedlings put on a growth of from 15" to 24" in Kanara at the end of the 1st rainy season, *i.e.*, by November and remain healthy till the end of the succeeding hot weather.

A suggestion about the inadvisability of removing the young seedling with a ball of earth will not be out of place here. I would go to the length of saying even that this "ball of earth" is a mistaken old idea. It is not required at all. On the other hand this is prejudicial to the free growth of the roots of the transplant. My own reasons are :—

(*a* when once the plant is subjected to the process of uprooting, the flow of sap or the root action stops at once, no matter what precautions you take in uprooting ;

(*b*) the frequent handling of the ball of earth or the coolies' zeal to keep the earth compact, hardens the soil, which, after transplanting, offers the young rootlets a much harder outer crust than the surrounding loosened soil ;

(*c*) it increases the dampness of soil in the ball of earth ;

(*d*) and lastly it increases the coolies' weight in the course of the journey to the planting site.

On the other hand, my plan is to shake off the original earth gently or even wash it out in running water which is always available at hand on rainy days, *i.e.* during transplanting work. This renders the root system clean and the new roots begin to grow at once. But the chief precaution to be taken is to protect the young plants from the sun or even light. For this reason good green packing material such as green grass or tender green leaves should always be arranged in broad shallow baskets and after the plants are put in, the same material should be placed gently on the top and the basket should be kept under shade in a cool place by the side of nallahs. If there is a little sunshine no transplanting of such young plants should be done at all. Evenings of course are best.

Kanara Nurseries.

An altogether new method of raising the plants *in "Dry Nurseries"* was started in Kanara lately by Mr. A. G. Edie (now Chief Conservator of Forests, Bombay Presidency). The method is simple and much less expensive than irrigated nurseries. Extensive areas of permanent nurseries can be made by this method and these being independent of water supply and artificial shade, are considered to be conducive to the production of hardy plants. Shade and watering tend to "draw" up the plant and make it very delicate.

Sow the seed rather thickly on germination beds long before *the rains set in, i.e. about March* and *April*. Cover it up with the usual layer of fresh, loose earth and leave it there till the rains come down. About the end of June (this is the case in all kinds of hard seed) a good percentage of the seed will germinate. Keep these till the end of July or middle of August and plant out on nursery beds 6″ × 6″ or 8″ × 8″ and leave them there till the end of the following hot weather. An occasional weeding is required. Also a light cover of green leaves or green grass over the beds is required about the end of August after the plants take root to prevent the earth being beaten over the stems and leaves by rain. Such plants thrive well and remain quite independent of shade and water. They grow hardy and become quite fit for the hardships of transplantation in the succeeding rainy season—June July (see figure 2, plate 10).

Another great advantage is that such nurseries can be established in the immediate neighbourhood of regeneration areas or even in the cleared areas themselves—on hill tops and on ridges and anywhere except damp places. This also saves a lot of time, labour and lead during transplantation.

Strictly speaking, in the case of teak, even these dry nurseries, which require to be kept for over one year, are really not necessary. No doubt they give good, strong hardy plants fit for planting by "stump" method, *i.e.* root-and-top-pruned plant. They are also useful where porcupine, etc., eat away the young teak. But they increase the cost per acre very much. A small

number of plants may be grown where steep hillsides are taken up for planting so that where seed gets washed and also where young two-months-old plants too do not stand these may serve as a reserve stock. But a more convenient and a much better and economical system would be to sow the weathered seed in small beds here and there in between the pegged out lines all over the regeneration area at the same time sowing is done. So that in July when the seed sown direct at stake fail in some stakes and where all extra plants grown at the stakes do not suffice to fill up the blanks, you can turn to these little nursery beds and take out whatever number you require. Because these one-to-two-months old little plantlets, if properly put in, on little mounds, as described in page 167, give much better results than the one-year-old dry nursery plants.

The great disadvantage of these bigger dry nursery plants is their big root system. They require much labour to dig out to carry and to transplant. I consider about 75 per cent. labour and cost could be saved by using the smaller plants. The bigger plants require another year to recover the shock of transplanting and there is no certainty that they will not fork out and become too branchy.

It should therefore be the aim of every officer in charge of teak planting work—

First—To use only the weathered seed and to sow it "in situ," *i.e.* where the tree is to remain for life.

Secondly—To use as much as possible one-to-two-months old little plants.

Thirdly—To have recourse to the "one-year-old" plants only as a last resource.

M. S. TUGGERSE, P.F.S.,
Divisional Forest Officer,
Kanara Coast Division

THE EFFECT OF METEOROLOGICAL FACTORS ON GIRTH-INCREMENT.

ÜBER DEN EINFLUSS METEOROLOGISCHER FAKTOREN AUF DEN BAUMZUWACHS, (I) † ÜBER DEN EINFLUSS AUF DEN STAMMUMFANG EINES TANNENBAUMES by HIROKICHI NAKASHIMA, Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan, Vol. XII, part 2, pp. 69—263, plates XI—XXVI; 1924.

Until quite recently it was generally supposed that the girth-measurement of a tree steadily increased from spring to autumn and then maintained the same size during the winter rest-period.

The work of Friedrich and MacDougal among others has shown that this is not strictly accurate, for it has been demonstrated that a decrease in girth may take place at certain times during the growing season and that even in the so-called rest-period marked increases and decreases may occur. These variations in the girth of the stem depend, (*a*) on the formation and extension of new cells, *i.e.* permanent increment, and (*b*) on the turgidity of the vascular system and are greatly influenced by meteorological factors.

Professor Hirokichi Nakashima has recently completed a continuous series of observations for five years on the growth of *Abies Mayiana* at the Forest Research Institute at Sapporo, Hokkaido. The instrument used, an increment-autograph or dendrograph devised by Friedrich, was described in the *Indian Forester* for 1923, pp. 293—301.

The chief results of the work at Sapporo may be summarised as follows :—The cycle of growth of a silver fir comprises four periods, (1) the growing-season from the end of April to the end of October, (2) the rest period from mid-December to the beginning of March and (3) and (4) the spring and autumn transition periods. Variation in girth measurement during these periods is closely connected with transpiration and absorption. Increased transpiration without corresponding absorption of

water by the roots produces a decrease in girth. Delayed transpiration in conjunction with absorption causes an increase. These manifestations are frequently of a large order and are dependent on meteorological conditions. In the rest-period fluctuations are mainly dependent on atmospheric temperature; in the growing season precipitation plays the most important rôle; in the transition period the equilibrium between transpiration and absorption is the determining factor.

Towards the end of March or the beginning of April the girth of the silver fir is at its lowest. True increment begins to form on an average about the middle of April, but the initial date may vary over a month. By the 24th June, *i.e.* 70 days after growth starts, 53 per cent. of the increment is laid down; in the next 70 days, *i.e.* up to September 2nd only 35 per cent. is formed. After the completion of the annual cycle the girth of the tree, as Professor Nakashima's graphs clearly show, may be less than the maximum reached during the previous growing season.

Similar information for some of the forest trees of India would be of value in many ways, *e.g.* in its application to the defoliation of teak; were the percentage of relative increment known for teak it would be possible to decide on which of the ten (or more) broods of the defoliators to concentrate control operations.

Professor Nakashima's investigations are in advance of those of previous workers in that he is able to express the relationships between Girth and Atmospheric Temperature and Girth and Rainfall by means of empirical formulæ.

The book contains 150 pages of close-columned figures, 42 graphs and is written in readable German.

C. F. C. B.

TIMBER SEASONING AND PRESERVATION.

THE SEASONING AND PRESERVATION OF TIMBER, by ERNEST G. BLAKE, M.R.S.I., A.B.I.C.C., London, Chapman and Hall, Ltd., 1924. Price 9*s*. 6*d*.; pp. 1—122, figs. 40.

Mr. Blake's book on the 'The Seasoning and Preservation of Timber is one in which the elementary principles of seasoning and preserving timber are simply and concisely expressed. It is not intended for the expert, but will be found of great interest to the general public.

Chapter II on the causes of decay is however very misleading as the author constantly refers to moisture as the cause of decay and a few lines later gives the modern and correct explanation, *viz.*, that decay is caused by the action of fungus and bacteria. It appears that the author is not too familiar with this subject. Moisture is a predisposing condition and not the primary cause of any kind of decay.

Chapter IV on the Drying and Seasoning Processes is simply and clearly written and describes the various processes as given by the originators but the author is very optimistic in thinking that a period of from seven to fourteen days immersion in soaking ponds or running streams will have much effect in accelerating the subsequent period of drying the timber.

The Chapter on Drying and Seasoning Plant calls for little comment, it contains concise and interesting descriptions of the better known apparatus for carrying out accelerated and controlled seasoning.

Chapter VI deals with "The Antiseptic Process" and gives a resumé of the evolution of modern antiseptics and methods of their application. The statement, however, that "Softwoods are naturally more susceptible to treatment than the harder varieties, as their absorptivity is greater" is much too sweeping to be accurate. One has only to cite the instances of spruce and Beech or Deodar and Sain to show that no such generalisation can be made, both Spruce and Deodar (softwoods) are very

difficult to impregnate whereas Beech and Sain (hardwoods) are comparatively easy; the anatomical structure of the wood seems to be the guiding factor, *i.e.* the presence of open pores and thin walled tissue, and not its commercial classification as a hard or soft wood.

Chapter VII on Impregnating Processes is not an impressive one. It is very doubtful if Franz Moll used Coal Tar Creosote; at that time the name Creosote was applied to the oil derived from Wood Tar and from his description of the preparation of the oil it would appear that he experimented with Wood Tar Creosote.

The classification of Creosote as 'London' or 'country' oil has little meaning nowadays as all Creosote used on the large scale is prepared to a specification which can be satisfied by a manufacturer in Newcastle, London, New York, or Timbuctoo, if he has the necessary Coal Tar and Apparatus. The Chapter on Preservations is a collection of cuttings from makers' pamphlets and price lists. The information will be very useful to prospective users until the prices are revised, but we fail to see why Messrs. Bart Boulton and Haywood's 'Silvertown' Wood Preservative has been overlooked, or why some of the salt solution preservatives have not been described. They are certainly worthy of mention.

The Chapter on Impregnating Plants is profusely illustrated but with the exception of the Powellising Chambers the illustrations might as well have been omitted as they give a very poor impression of what a preserving plant lay out should be. The Chapter on Dry Rot; its Origin and Cure is really good. Here the author is on more familiar ground and very clearly, concisely and accurately describes how the trouble arises and what steps to take to prevent it. This Chapter is of much more value than the rest of the book and may profitably be read by anyone interested in the subject.

TREE ANCESTORS.

Tree Ancestors by E. W. BERRY, *Professor of Palæontology in the Johns Hopkins University*, 1923.

As far as we are aware, this is the first book to be published with the object of familiarising the general public with the geological history of the existing genera of trees. It deals with most of the important trees of N. America with the exception of all the conifers other than *Sequoia* and *Taxodium*. Most of the genera concerned are common to the temperate regions of both New and Old Worlds, and so are equally familiar to us in Europe and N. India, the remainder occurring in one only of these two regions, or in E. or S. E. Asia outside India : very few are purely occidental.

It is a pity that at least *Pinus* of the conifers could not be touched upon, even if only to the extent of illustrating the difficulties of identification of fossil remains. One regrets that their absence from the existing flora of N. America justifies the lack of any account of the more tropical orders, as well as the better known types of the southern hemisphere such as *Araucaria* and *Eucalyptus*. Similarly one would like a note on the data for the orders with more highly organised flowers such as *Verbenaceæ*.

Certain omissions which detract from the general utility of the work are clearly due to the desire to popularise the subject matter, but will be none the less regretted by the serious reader, *e.g.*, the absence of all references to literature, a very inadequate index, and excessive repetition. References can easily be given in footnotes or at the end without scaring the general reader and a poor index will mar any book on a scientific subject: the repetition is due to the method of presentation, each genus being given a separate chapter. Other defects which should not have been overlooked in the editing are references to maps which have not been reproduced (pp. 228, 236), or which appear elsewhere in the book without a page reference (*Fagus*, pp. 121, 135); the headings in Chapter VI are very confusing.

None the less, the book collects in an interesting way a lot of information otherwise difficult to come by, and the illustrations and distribution maps are useful.

Thirty-seven genera are separately dealt with, of which 19 are also Indian, including such familiar ones as *Juglans, Quercus, Celtis, Rhus, Acer, Fraxinus* and *Diospyrus* whilst there are brief references to others such as *Sterculia, Grewia* and *Castanopsis.* All the N. European broad-leaved trees find their place.

A brief resumé should be of interest to those concerned with trees in India, though not unnaturally the majority of our Indian timber trees are not discussed, not being represented in N. America, so that we must go elsewhere for information concerning the past history of our *Tectona, Terminalia, Adina, Dipterocarpeæ* and so on.

Our modern temperate forest trees are almost all to be traced back to the Cretaceous period at the end of the Mesozoic era, though some are not found before the Eocene at the commencement of the Tertiary (*e.g. Ulmus* and *Fraxinus*), and some few conifers (*Sequoia*) occur in the Jurassic period which must have seen the origin of Dicotyledons and most of their leading types. In the upper Cretaceous and Eocene, there is a very striking northward extension of temperate forest types even to within 10° or 12° of the Pole, leaving abundant evidence in deposits of this age in Greenland and Spitzbergen: this is ascribed to extension and elevation of land surfaces, and corresponding restriction of oceans—thus central N. America was at this time under an extensive but quite shallow sea. In the Cretaceous, there were numerous survivals of the lower fern, cycad, and conifer types, but in the Eocene, the better characterised of our existing genera are nearly all recognisable, and unquestionably dominated in extensive forests stretching right up into the arctic regions. The Eocene is well represented in America and Europe, but the following Oligocene, Miocene and Pliocene are far better known in Europe, though America has some few very rich collections such as that of the fossil lake of Florissant in Colorado. The paucity of records in the Oligocene

is thus due to lack of records rather than of forests, as is evidenced by the wonderfully numerous records from the Miocene which seems to have been the zenith of the development of forests, especially in Europe.

The elevation of mountain ranges such as the Rockies in the early part of the Tertiary (which also saw the rise of the Himalaya), seems to have initiated prairie grass and shrub formations by reducing precipitation over large areas, and a diminution in the range and variety of tree genera is noticeable.

The Pleistocene with its periodic great extensions of ice-sheets, saw the end of a very large number of forms, especially in W. Europe, where the east-to-west orientation of the ranges and inland seas seems to have prevented southward migration before the ice-sheets, to regions whence they could once more spread out when favourable conditions recurred, as they did in N. America and S. E. Asia. Thus *Diospyrus*, *Liriodendron*, *Hicoria*, *Liquidamber* and *Rhus* are not found in W. Europe after the Pliocene, whilst *Sassafras* and *Platanus* survived only one or two of the glaciations. Some genera, however, such as *Nyssa* appear to have died out in Europe from other causes even earlier.

Pleistocene trees are for the most part indistinguishable from existing species (though frequently outside their present distribution) but those found in Pliocene deposits, are generally different though some are not such as European *Liriodendron*, which cannot be separated from the existing *L. tulipifera* of N. America, and similarly for *Taxodium distichum* in that country.

One of the chief points of interest in these studies is the light they throw on apparent anomalies of modern distribution, particularly the frequence with which existing genera are represented only in N. America and in E. or S. E. Asia (*e. g.*, *Hicoria Liriodendron*, *Liquidamber*, *Hamamelis*, *Gleditsia*, *Osmanthus*, *Nyssa*, *Sassafras* and *Benzoin*), or exhibit maximum variation in these two areas (*e.g.*, *Fraxinus* and *Acer*). All the evidence points to the origin of the bulk of our N. Temperate tree genera, and many which extend southwards across the equator (*Diospyrus Salix*), and even some confined to the southern hemisphere

(*Nothofagus*, *Aracauria*) in northern lands, most probably north of America and E. Asia, and a spread thence southwards in those two continents, and to Europe by either route. The few Australian forms may have arrived there *viâ* the Malay, or *viâ* an antarctic continent, and similarly for S. Africa.

As typical or specially interesting cases, the following may be quoted :—

Fraxinus (Ash) first occurs at the top of the Upper Cretaceous in W. Greenland: 12 species are found in the Eocene in America only, extension into Europe having taken place in the Oligocene as evidenced by inclusions in the Baltic amber of that age. (The amber is probably derived from *Sequoia*-like conifers). Maximum development is found in the Miocene both in N. America (7 species are preserved in the Florissant Lake), and in the Mediterranean. A reduction appears to have occurred in the Pliocene when some of the modern species, such as *F. ornus*, first appear; and similarly in the Pleistocene, but some species were hardy or adaptable enough to survive through the severities of that epoch to the present day over most of the range. This history is typical of the majority of the genera in question.

Fagus (Beech) has a very similar history, except that it must have originated rather more to the south, as it is not found in the Cretaceous of Greenland though then present in Japan and Vancouver. The closely allied genus of *Nothofagus*, now confined to the Southern Hemisphere, is generally found with *Fagus* in the Eocene and Oligocene in both hemispheres, but has since died out in the northern, just as *Fagus* has disappeared from the southern. *Fagus* was also lost to western N. America in the Pliocene.

Sassafras (*Lauraceæ*) has changed but very little since the Lower Cretaceous, when it occurred in Portugal and Virginia. It is very common and widespread in the Upper Cretaceous which seems to have seen its maximum development, and is represented by several species in the following three epochs. One species survived in France right down to the third interglacial period but the ice-sheets made an end to all but the common eastern

N. American species and the two others occurring now in China, *Liriodendron* (tulip-tree), representing the equally tropical order. *Magnoliaceæ* has an almost exactly parallel history, except that it did not persist in Europe quite so long, so far as is known.

H. G. C.

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THE TEAK CANKER-GRUB (*DIHAMMUS CERVINUS*).

One of the disadvantages of pure plantations of quick growing species in semi-tropical forests appears to be their liability to attack by large borers,—the larvæ of moths and beetles. In recent years it has become evident that teak plantations have to contend against a pest of considerable importance,—a longicorn beetle, *Dihammus cervinus* Hope. [family: Cerambycidæ.]

This species is responsible for the formation of large spherical swellings at the base of or a short distance up the stems of teak saplings; the swellings are often much fissured or cankered and persist for several years.

Distribution.—The species is known from Japan, China, Burma, Assam, Bengal and North India. We have records of its occurrence in plantations or in natural teak in the following Divisions: *Burma*: Zigyun Reserve, Myitkyina; Bilumyo and Petsut Reserves, Katha; Namma Reserve, Northern Shan States; Mansi; Kaing and Yanaungmyin Reserves, Pyinmana; Bondaung Reserve, South Toungoo; Arakan; *Bengal*: Sitapahar Reserve Chittagong Hill Tracts; Hazari Khil Reserve, Chittagong; *Assam*: Sibsagar; Garo Hills; Kulsi, Kamrup; Sylhet; Goalpara, and in *Nepal* and *Bihar*; Pusa.

It is unknown in the teak areas of the Indian Peninsula.

The life-history of the insect as far as known is as follows:—

The beetles begin to appear in April with the onset of the rainy season and feed on the soft bark of saplings gnawing this

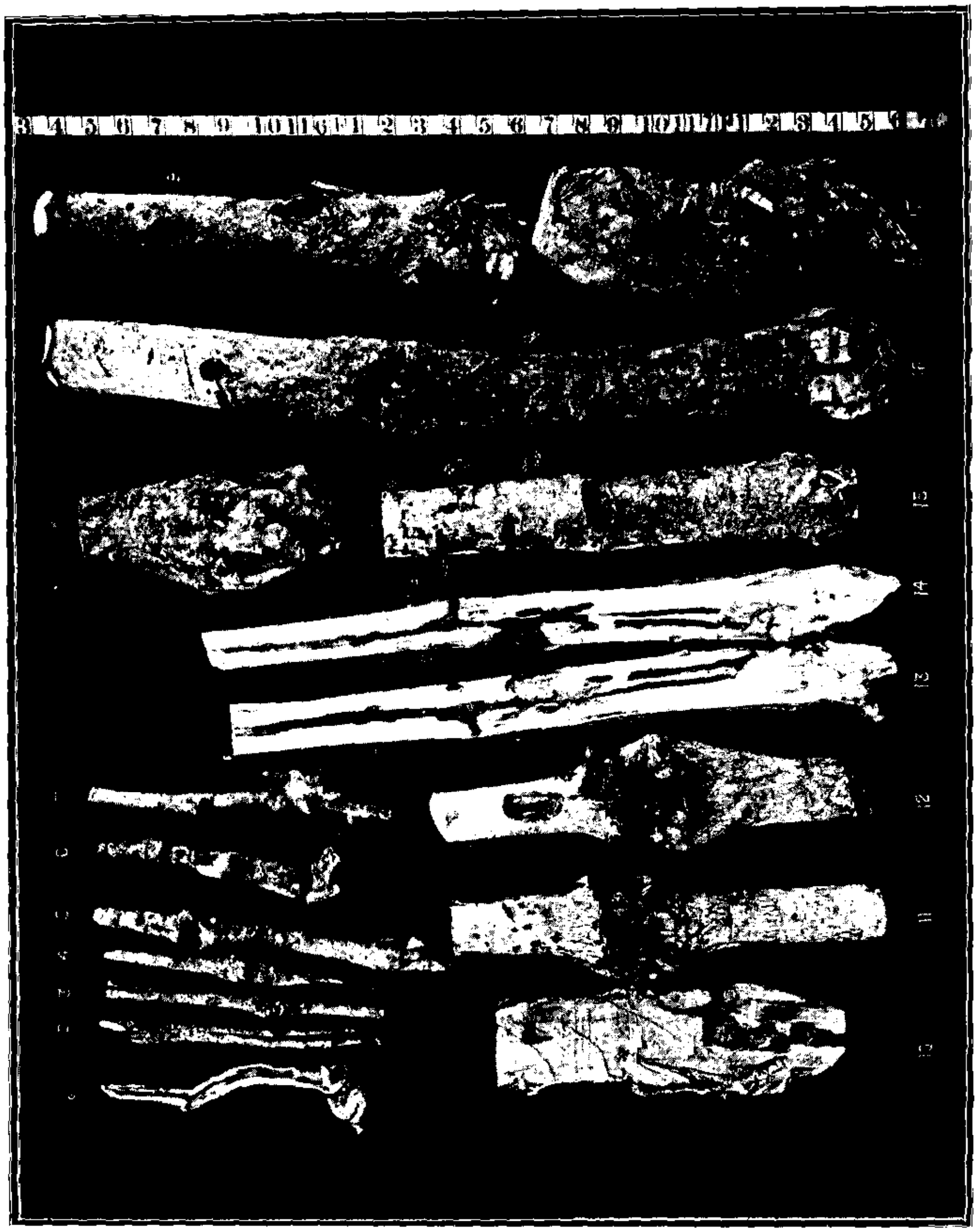
shallow irregular patches. They are a half to one inch long and of a uniform brown colour like several other allied species. The eggs appear to be laid low down on the stem of the tree and during the growing season the larva bores in the region of the inner bark and sapwood. At first the tunnels are broad and flattened and are usually concentrated in an irregular patch, but later are carried into the heart of the stem and tend to run longitudinally upwards or downwards.

Damage.—The injury to the cambium, in the case of teak induces an increased formation of wood around the wound, which is also bored in later stages. As a result of continued irritation in the callus and browsing-back of the newly formed bark, a bulging carrotty base or a globular canker twice the diameter of the stem is formed by the following spring. A canker may be the work of only one larva, but more often two or three larvæ are responsible. In Plate 13, figs. 10—12 show typical cankers on young teak saplings, that in fig. 10 being a longitudinal section. Most of the damage is done near ground level, where, hidden by undergrowth it escapes notice, but a single sapling may have two or more separate cankers, the highest rarely being above 3 feet.

In March and April the larvæ pupate giving rise to beetles in the following months ; the life-cycle is therefore annual.

The cankers may be the site of further attacks in subsequent years but more often they are neglected by later broods. Healing of the wounds is frequently delayed by the activities of termites and true ants (*Formicidæ*) which may fill up the cavities with mud or assist the development of rot. In case of extensive tunnelling by the canker-grubs, or of enlargement of the tunnels by woodpeckers, the stem is so much weakened that it breaks off. Fig. 12 shows a teak sapling broken in two at a canker.

Alternate Food-plants.—The teak canker-grub, ***Dihammus cervinus***, is also pest of *Gmelina arborea*, but its effect is somewhat different to that in teak. Possibly because the growth of *G. arborea* is on the whole more rapid than that of the former species, the tunnels of the grub in the region of the cambium are not so extensive and the formation of callus is less abundant. The larval tunnels are carried earlier into the heart of the sapling and



Work of the teak canker-grub (*Dihammus cervinus.*) (For description see page 191.)

tend to keep to a longitudinal direction in the wood (see figs 13 & 14). Consequently on *Gmelina* poles there is rarely more than a slight bulge as external evidence of the attack of the borer (see figs. 15 and 16).

Longitudinal and transverse fissures are formed but these appear to heal more rapidly than in teak. The base of the stem however is often much distorted and thickened (see figs. 8 and 17).

Saplings of *Gmelina* may break off at a canker particularly if the wound is enlarged by wood-peckers.

A study of the distribution of *Dihammus cervinus* in India suggests that neither *Tectona grandis* nor *Gmelina arborea* is its primary natural food-plant. Teak was first introduced into the Chittagong Hills in 1871 and a borer, which must certainly have been this species, was noticed in 1873-74. It was also present in 1873 in the Kulsi teak plantations in Kamrup*. Plantations made in recent years in Assam and Bengal in areas where no teak previously existed were similarly attacked in the second and third years. With this evidence a search was made for possible alternate food-plants one of which was found to be *Clerodendron infortunatum.*

The borer occurs in pure patches of *Clerodendron infortunatum* about 4 to 6 feet high in stems of the thickness of a pencil and over. It is most abundant in young growth with a closed canopy: and is absent from isolated plants and shrubs that have been repeatedly coppiced. The abundance with which the borer occurs in *Clerodendron* indicates that the shrub is a natural host. The major portion of the attack is in the root which is hollowed out.

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* Stebbing was evidently unacquainted personally with this species. In 1899, (Inj. Ins.. Indian Forests, pp. 73 and 76) he refers it to *Stromatium barbatum* and *Stromatium asperulum.* In 1914. (Ind. For. Ins., p 293) he refers it to *Stromatium longicorne* and reproduces the earliest account of the teak canker-grub, which was published by A. G. Mein in the *Indian Forester* for April, 1879, p. 347. Mein's description of the globular swelling just above ground-level and his comparison of the beetle with the European *carcharias* make it certain he was dealing with a lamiine borer. Stebbing's species of *Stromatium* (a cerambycine) was selected from a miscellaneous lot sent to the Indian Museum, Calcutta, in 1890. The account of the *Stromatium longicorne* in Indian Forest Insects, pages 293, 294, and figs. 203-204 should be deleted as a sidentification.

A proliferation or canker is found at soil-level and in thicker stems small swellings occasionally occur up to about 2 feet ; at such points breakages may take place. Figs. 1—7 of Plate 13 show a group of stems and roots of *Clerondendron infortunatum* attacked by *Dihammus cervinus*.

Age of trees attacked.—The borer is undoubtedly more abundant in *Clerodendron* than in tree plantations of the same locality Data on its incidence in teak and *Gmelina* have been collected this year in the Sitapahar Reserve, Chittagong Hill Tracts, Bengal, and in the Raghunandan Reserve, Sylhet, Assam.

Chittagong Hill Tracts.

	Gmelina arborea.	*Tectona grandis.*
First Season	*nil.*	*nil.*
Second „	7 to 47 per cent.	27 to 31 per cent.
Third „	3 to 13 „	29 to 65 „
Fourth „	4 „	17 „
Fifth „	...	15 „
Seventh „	...	25 „

Sylhet.

Tectona grandis.

First season	*nil*	of the attacked trees 13 per cent. were broken off at the canker.
Second „	75 per cent.	

Evidence from other localities indicates that teak outgrows its liability to serious damage in the seventh or eighth year, while *Gmelina* acquires immunity at an earlier age.

An infestation of one-third to one-half of the crop appears to be not unusual in the moister regions.

Possible Control Measures.—Theoretically the most efficient as also the cheapest protective measure is the killing of the early stage larvæ by slitting the bark tunnels in the first months of development, *i.e.*, in July or August. The method requires very little intelligence as the site of attack is readily recognisable by an exudation of sap and frass, but it depends in practice on the honesty of the labour employed. Since the accuracy of application cannot be checked until several months later the method must be rejected where supervision is not reliable.

2. Oviposition on the lower parts of the stem may be prevented by deterrents such as tar, creosote or carbolineum painted on early in May. The cost of materials is likely to be prohibitive but experiments are desireable.

3. Oviposition may be prevented by a barrier or wrapping of grass, shrubs, etc. The undergrowth, which is usually cut back at the time when the beetles are ovipositing, can be stacked upright in sheaves round the stem of the tree and tied in place with 2 or 3 twists of grass or creeper, so as to conceal the bark entirely from ground-level to the lower leaves. In most localities the undergrowth has to be cut in any case, so that the operation involves only the extra cost of applying to the trees, say eight annas to two rupees per acre.

The last measure appears to be the most worthy of a fair trial before more expensive and less straightforward alternatives are worked out, and arrangements have been made to test it this season in plantations in Sylhet and the Chittagong Hill Tracts.

Possibly these notes may be of use to Divisional Officers, in other localities where the pest is serious.

DESCRIPTION OF PLATE 13.

Showing the attack of *Dihammus cervinus* Hope.

Figs. 1—7, *Clerodendron infortunatum*—portions of stems and roots.

Figs. 10—12, *Tectona grandis*.—Fig. 10 (reversed) shows a longitudinal section through a stem-canker with larval galleries and pupal chamber. Fig. 11 shows the external appearance of a globular canker. Fig. 12 is from a sapling broken in half at the canker; the upper portion has been bored by a wood-pecker.

Figs. 8, 9 and 13—17, *Gmelina arborea*.—Figs. 13 and 14 are two halves of a split sapling showing the extended larval galleries. Figs. 8 and 17 show the distorted growth at the base of the stem just above soil-level.

Figs. 9 and 15 and 16 show the external appearance of attacked stems and the absence of globular cankers.

(The scale is indicated by the tape measure.)

C. F. C. BEESON, I.F.S.,
Forest Entomologist.

SUITABLE FIELD CROPS FOR *SAL TAUNGYA* IN THE UNITED PROVINCES.

It would be no exaggeration to state that of all the tropical species a forester has to deal with in India, *sal*, perhaps, is one of the most puzzling to regenerate.

Various methods have been tried in the past in the artificial regeneration of this species and a close analysis of them shows that success varies in direct proportion to the care the seedlings receive from the human hand. In other words, areas properly tended have given far better results than the ones left to their own fate after sowing.

Hence, of late, the *taungya* system of artificial regeneration is coming more and more into prominence everywhere and endeavours are being made to introduce it in places wherever it may be possible.

Not only does the *taungya* system afford a plentiful supply of labour in and out of season but it may also diminish the chances of what we call "Budget fights" in legislatures. However, the question of regeneration is not solved by the mere introduction of cultivators. Next to tending, the proper selection of nurses, which under the *taungya* system means the field crops, is equally important. Thus, by judicious choice we could select according to the demands of the locality those field crops which will prove of great benefit to the tender *sal* seedlings. Neglect this question and at least half the charm of the *taungya* system will be gone.

It is now my intention to name a few field crops, ordinarily grown in this province with their merits and demerits with regard

to the healthy development of *sal* under the *taungya* system in different parts of this province.

To begin with we must not allow the cultivator such field crops as are likely to interfere with the proper growth of *sal*. For instance, sugar-cane is to be rigidly ruled out from the list of all *sal taungya* field crops. The cane is sown somewhere in April or May and earth is heaped up in lines round the base of the cane plants almost immediately it has grown to a height of a foot or so ; which in other words means that by the time the monsoon breaks and the *sal* seed is sown, there will be a set of furrows and ridges throughout the field, on the ridges the sugar-cane will be growing and the *sal* seed will only be sown in the furrows, with the result that the rain-water will remain standing for a time and the *sal* seedling will die out on account of excessive moisture, immediately after germination.

Apart from this, sugar-cane will also interfere with a proper light supply; as it grows very thick and high; while in places where there is any danger from frost it will be almost a fatal mistake to grow sugar-cane, for, it is cut away precisely at the time in the cold months when the *sal* seedlings urgently require shelter from frost, and the dead cane leaves strewn about in the field attract frost all the more. Prior to the advent of ice-machines the Hindustani ice-cream *wallas* used to get their ice supply by putting earthen bowls, full of salted water, on a carpet of thatch-grass or *dead sugar-cane leaves*. From the protection point of view, also, it is not advisable to grow sugar-cane on *taungya* fields, as it attracts pigs in great numbers.

KHARIF OR MONSOON CROPS.

In *kharif* the following field crops could be grown successfully according to the requirements of the locality, each of which will be dealt with separately.

(1) Paddy, (2) Indian corn, (3) Millets (Jour, Bajra), (4) Sawan, (5) Kakun or Kangni, (6) Mendwa, (7) Arhar, (8) Cotton, (9) Hemp.

Paddy is rather a general term which includes various varieties of rice ; but there are two great sub-divisions in this family, *viz.*, (*i*) planted rice, (*ii*) the rice sown *in situ*.

The planted rice is to be ignored altogether so far as the *sal taungya* is concerned, as it only grows on soils which are flooded with rain-water and *sal* only grows on well drained soils. Planted rice, however, is a good companion in a *sain* (*Terminalia tomentosa*) *taungya*.

(*ii*) The rice sown *in situ* consists of various coarse varieties which are sown soon after the rains break, and, sometimes in some localities even before the monsoon breaks. Although they can stand water yet they prefer to grow on well drained soils. They do not require a too finely ploughed field and in many cases, going over the field with a spade is enough. This is a great advantage, as the less the *sal* lines are disturbed by plough after sowing the more profusely and regularly they germinate and grow. Rice crops are weeded two or three times by the cultivator during the rains who also weeds the *sal* lines when he is weeding his own crops without any sense of extra work.

Practically all sown rice varieties are reaped by the end of September or the middle of October and give just enough time to again prepare the soil and sow it with *rabi* crops (cold weather crops) which experience has proved, are so very necessary for the proper development of *sal* in *taungya* areas.

Each locality has given different names to the hundred and one varieties of coarse rice and therefore it is futile to name them here. But a special mention could be made of *satha* or *sathi* rice which is called by this name, practically, over the whole province and is a very good rice to be sown in *sal taungyas* as it ripens in 60 days and the grain bearing ears remain hidden under the folds of the leaves until it is reaped and consequently is well protected against external injuries. In Gorakhpur district *sarya* rice is the usual variety and has grown well in *sal taungyas*. *Sathi* is also grown but to a lesser extent.

As none of the coarse varieties grow to a very great height the question of screening the *sal* seedlings from light does not arise and if they are ever found over topping the *sal* they could be pressed back on either side of the *sal* line without any damage to the grain.

(2) Indian corn is sown on well drained light soils. It is sown rather sparse and puts on a height growth varying from 5′ to 10′ in 3 months time. It is also sown immediately after the break of the monsoon and is reaped by the end of September or middle of October. In a heavy monsoon year the height growth becomes stunted as it does not like incessant rainfall. The soil under it has to be kept loose and clean and broken throughout the rains and therefore *sal* lines are kept best weeded under this crop. As it is sown sparse and there are very few leaves on the lower part of the stem there is always enough light on the *sal* seedlings. To ensure proper supply of over-head light bunches of 4 or 5 plants are tied together on either side of *sal* lines like the B. S. A. trade mark. This, however, does not interfere with their own growth and development. *Rabi* can be sown on the soil which produced Indian corn during the rains.

(3) Millets—Their requirements are more or less identical with that of the Indian corn. Only they grow higher than Indian corn and are reaped late in the season so much so that it becomes difficult to sow the *rabi* on the same field. They are sown thicker than maize and throw much shade on *sal* seedlings from the middle of September to the beginning of November. Hence the introduction of these field crops into *sal taungya* is to be discouraged.

(4) *Sawan*, (5) *Kakun*, (6) *Mendwa* are cheap grains which are chiefly grown mixed with the coarse varieties of rice. They get ripened earlier than the rice. They prefer a well drained light soil. To the poor cultivator they form an excellent mixture with rice as they are reaped earlier than rice and are served in the dishes of the poor when the rice is yet growing. They are a very good companion for *sal*.

7. *Arhar* is a pulse tree which is sown at the commencement of the monsoon either pure or mixed with rice on well drained soils. It does not like excessive rain and hence in a heavy monsoon or where there is water-logging *arhar* will prove to be a very poor crop. It is a leguminous crop with a long carrotty tap-root, which very much helps to break and aerate the sub-soil. It grows for about 10 months and is reaped in

the beginning of April. If sown mixed with paddy or *mendwa* the latter are reaped in September or October from under it. It blossoms in the coldest part of the year and is a comparatively frost hardy species. Its height growth varies from 5′ to 10′ and produces numerous side branches. The last named qualifications combined with its frost hardy nature makes it an excellent nurse for *sal* in places where there is much danger from frost. But it tends to retard the growth of *sal* during the cold weather owing to the heavy shade it throws. This, however, is to be ignored n places of heavy frost where its (*sal's*) very life is at stake and *arhar* undoubtedly will prove a good nurse in such areas.

Another disadvantage from *arhar* is that it shelters wild pigs very considerably and great care must be taken in fencing the area.

In places where there is some danger from hot winds in May and June *arhar* trees should be left standing until the rains break. Only the pulse bearing pods should be picked out as soon as they are ripe in April. The *arhar* plants will continue to be green the whole season and will preserve the moisture of the soil as well as protect the *sal* seedlings against hot winds. As soon as the monsoon sets in they could be cut away and either paddy or again *arhar* could be sown at once, after hoeing up the area only once with a spade and digging out the roots. Thus *arhar* proves to be a very good nurse both against frost and the *loo*. Only the *sal* grown under it will be poorer in height growth than the ones grown outside on account of heavy shade.

8. Cotton.—The writer has no personal experience of this species as a field crop in *sal taungyas*. But judging from the requirements of cotton plants it appears that it will probably prove to be a good companion for *sal* Experiments have yet to be made with this species.*

9. Hemp is sometimes grown mixed with paddy, but it does not form more than 2 or 3 per cent. of the crop It should not, however, be allowed to grow in pure crops in *sal taungyas* as it is sown very thick and grows very high (5′ to 10′) and is

* Cotton is commonly grown in *sal taungyas* in Bengal.—HON. ED.

reaped late in the season conditions, every one of which are injurious to *sal*.

RABI OR COLD WEATHER CROPS.

After the *kharif* is reaped we should try and induce the cultivator to put in the *rabi* crop. Not only that it helps to enrich the cultivator by having double crops in one year but that experience has proved that it is almost a necessity to grow *rabi* in *sal taungyas* in U. P. for many reasons.

Firstly it helps to preserve the moisture in the sub-soil for a considerable time and thereby diminishes the chances of dying back from drought. Secondly it protects *sal* from frost damage very considerably. Thirdly the *sal* lines get better protection against wild animals and other injuries owing to the constant presence of the cultivator.

Among the chief crops grown in winter the following will be discussed with regard to their advantages and disadvantages in connection with *sal taungyas* :—

(1 Wheat and Barley, (2) Linseed, (3) Mustard, (4) Gram and *Masoor*, (5) Peas.

(1) Wheat and barley are not very good companions for *sal*. In the first instance, they are sown on a very finely ploughed and cross ploughed soil, which process is likely to injure the *sal* lines already growing there. Secondly they are a very delicate crop and in the majority of cases require watering by artificial means. Experience has proved that kachha wells dug in forest lands cannot meet the irrigation requirements of such fields. Then again, they are sown rather dense and are reaped late in the season, *i.e.*, at the beginning of the hot weather and put on the average a height growth which may be anything between $2\frac{1}{2}'$ to $4\frac{1}{2}'$. Thus in the latter days of their growth the *sal* will remain swamped within them. When they are reaped late in the season the tender *sal* which has lived a sort of *purdah* life during the last two months will abruptly be thrown open to stand alone by itself and a good many deaths are likely to occur. But in places where there is danger from late frosts they will prove a valuable nurse and should be sown with preference.

Linseed is sown either pure or mixed, and so are mustard, peas, gram and *massoor*. I will not describe them separately because they serve our interests better when sown mixed as I will now describe.

They are called the coarse *rabi* crops as they can be sown on soils from which *kharif* has been reaped and the soil has only to be gone over with a plough or spade once or twice. They can be sown in one of the two mixtures—

(1) Linseed, mustard, and gram and *ma ssoor*.

(2) Mustard, peas, gram or *massoor*.

Both the above mixtures are sown by the middle of November at the latest and germinate quickly. Mustard is the tallest plant among them which grows very quickly. It flowers and seeds in the later days of December and is reaped by the end of January. Linseed and peas stand second in height growth to mustard and are reaped in February. Gram and *massoor* form the lowest tory of the crop and are reaped in March and April.

It is now obvious that in both the above named mixtures the crop is removed in three distinct operations at more or less equidistant intervals.

Frost danger diminishes after January and the tallest crop is reaped out giving better play to sunlight over *sal* lines. Next month the second story removed by reaping out the peas, and linseed, and, ultimately, the lowest story of gram and *massoor* is taken out just at the beginning of hot weather.

Thus, by removing the nurses in three successive stages we make the *sal* self-reliant, so that by the time the last nurse is removed *sal* can well afford to stand by itself. As a matter of fact in the above mixtures, we find the best possible nurses for *sal* seedlings under the *taungya* system. Mustard is removed immediately after its presence is no longer required for protection against frost; then the second story and then the third—a process very much resembling the removal of overhead stock in a well regenerated block in three successive operations in miniature.

M. SHAUKAT HUSAIN,
Forest Ranger, Gorakhpur, U. P.

OIL FROM THE FRUIT OF *CARAPA MOLUCCENSIS* AND *C. OBOVATA*.

Apparently on the strength of the fact that certain species of *Carapa* yield a considerable quantity of better fixed oils, *e.g.*, *C. guyanensis*, *C. guineensis*, and *C. grandiflora*, the statement has been made that *C. moluccensis* also yields a quantity of fixed oil which according to Wijs (quoted by Heyne in Dic. Nuttige Planten van Nederlandsche Indie, Vol. 3, pg. 45) reaches 40 to 60 per cent.

Watt in the Dictionary of Economic Products states that it yields a semi-solid fat, but does not give the percentage. Lewkowitch following Watt mentions that *C. moluccensis* yields an oil similar to *C. guyanensis* which gives the andiroba oil of commerce.

In connection with the collection of exhibits for the Wembley Exhibition samples of the fruits of *C. moluccensis*, Lamk, and *C. obovata*, Blume, were sent from the Bassein Division in Burma to the Forest Research Institute, Dehra Dun, but on treatment by solvent extraction gave only the following amount of oil according to the Forest Chemist:—

$$\left.\begin{array}{l}\textit{C. moluccensis}\\ \textit{C. obovata}\end{array}\right\}\text{ about 1 per cent.}$$

This almost negligible quantity led the writer to believe that some mistake had been made in the collection of the fruit and that possibly it had been collected unripe. In 1924 the writer obtained a further consignment of fruit from the Tavoy Division in ripe condition and at his request Dr. Peacock of University College, Rangoon, very kindly carried out a further extraction in the University Laboratory, giving for *C. moluccensis* dried at 100° C:—

With Ether 0·98 to 1·55 per cent. of oil.

With Petrol Ether 2·12 per cent. of oil.

This confirms the result obtained at Dehra Dun and it is therefore necessary to revise the general statement as to the oil content of the fruits of these species at any rate for Burma and presumably for India also.

It is interesting to note that none of the inhabitants of the country neighbouring the mangrove forests to Tavoy or Bassein have any knowledge of an oil to be obtained from these fruits.

W. A. ROBERTSON, I.F.S.

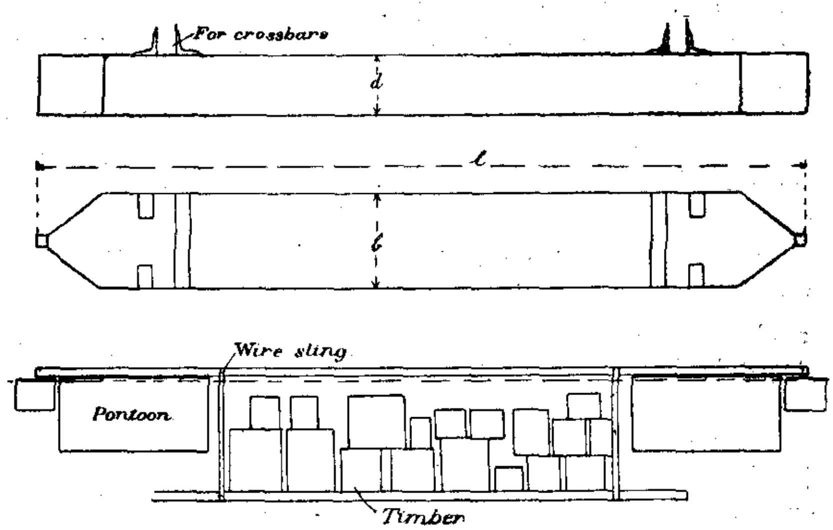
IRON FLOATS FOR LOGS IN THE BANDON DISTRICT, SOUTHERN SIAM.

In the September 1923 number of the *Indian Forester*, on pages 524 and 525 a short article entitled "Iron floats for logs" was reprinted from "The Literary Digest," and the article was originally taken by the above paper from "The Pure Iron Age" of Chicago, U. S. A. This article described some iron floats used for transporting heavy woods, which would not float in water, down certain rivers in the northern provinces of the Argentine Republic, in South America. This article was sent in by the Forest Economist, Dehra Dun, if I remember rightly, and as the subject appears to be of interest to him, and may perhaps also be of interest to other readers of this paper, I am sending the following particulars of some iron floats which I saw in use a short time ago in the Bandon district of Southern Siam, while I was touring in those parts.

During the past seventeen years or so the East Asiatic Company, which is a Danish concern, has been extracting dipterocarp timber and also other miscellaneous hardwoods in various parts of the Bandon district and has been employing various systems of extraction. At present the Company is exploiting some forest areas at Tha Mai Liam, a place situated about 30 kilometres south of Bandon. Bandon itself is situated about 10 kilometres from the mouth of a large river, near the Eastern coast of the Siamese portion of the Malay Peninsula, about 600 kilometres south of Bangkok. The absence of accurate large scale maps in those parts makes it very difficult to give distances with any degree of accuracy.

The methods of working the forests at present employed by the Company may be briefly described as follows :—

The Company has a narrow-gauge tram-line running about 8 kilometres into the forests with a number of side branches. The dipterocarps and other trees above a fixed girth, to be felled by the Company, are marked by the Forest authorities. The Company fells the trees, saws them up into logs and drags the logs with elephants to the tram-line. Elephants load the logs on to trucks and pull the trucks along the up-grades for about half the distance, on the down-grades they are released and run downhill by their own weight controlled by men and brakes, and the trucks finally run down a steep incline to a river, a tributary of the Bandon river. When they have arrived at the river the trolley-men tip them over into the water. A small colony of Siamese raftsmen live on floating house-boats near the end of the tram-line; they make up the logs into rafts and float them down with the tide to Bandon, where they are taken up into the sawmill, converted into planks, scantlings, battens, etc., and eventually despatched by sea to Bangkok.



Above : Elevation and Plan of Iron Pontoon. The larger size pontoon has a length of 31′ 6″, breadth of 4′ 2″ and diameter of 2′ 6″; carrying capacity 1,500 cubic feet. The smaller size pontoon has a length of 21′, breadth of 4′ 3″ and diameter of 3′; carrying capacity 1,200 cubic feet.

Below : Method of carrying squared timber by means of pontoons and slings.

There are really three kinds of rafts made up. Some logs float on their own and are easily tied up with canes into rafts and sent down to Bandon. Other logs either half sink or sink completely. These are either buoyed up with bundles of bamboos as floats and securely lashed everywhere with canes and made up thus into rafts or they are rafted by means of iron floats. These iron floats or pontoons are made up of iron plates $\frac{1}{8}''$ thick rivetted together and painted red. They are rectangular in section and have both ends pointed. Two sizes are employed, the larger size has a total length of 31′ 6″, breadth 4′ 2″, depth 2′ 6″, with a carrying capacity of 1,500 cubic feet of timber submerged. The smaller size has a length 21′, breadth 4′ 3″, depth 3′ with a carrying capacity of 1,200 cubic of timber submerged.

The method of using them is as follows:—

The floats have at both ends two iron attachments rather like the rowlocks of a boat. The dipterocarp timber, which constitutes the greater part of the output is sent down to the mill as round logs. When rafting these round logs stout poles are fitted into the "rowlocks" and secured, lashed into position with wire or canes across a pair of floats at both ends; these poles overlap for a short distance outside the floats. The raftsmen then lash tightly with canes as many round logs as the floats will carry, side by side between the pair of floats, on to the wooden cross-bars above, and they also lash one or two logs on the overlapping portions of the wooden cross-bars, outside the floats. From what I could see, about one dozen round logs are carried thus. These made-up rafts are guided by the men with long bamboo poles and they take from one to four days to go from Tha Mai Lium to Bandon, according to the tides.

The Company also exploits a certain amount of miscellaneous jungle hardwoods. These are cut into squares or baulks of various sizes before rafting them down Bandon. When rafting these hardwood squares a different method is employed, which is as follows:—Four wooden cross-bars are used, two as usual, on the top of the pair of floats, and two in the water underneath the two floats. The upper and lower cross-bars are fixed together by means of wire slings, and the squares are then simply pushed

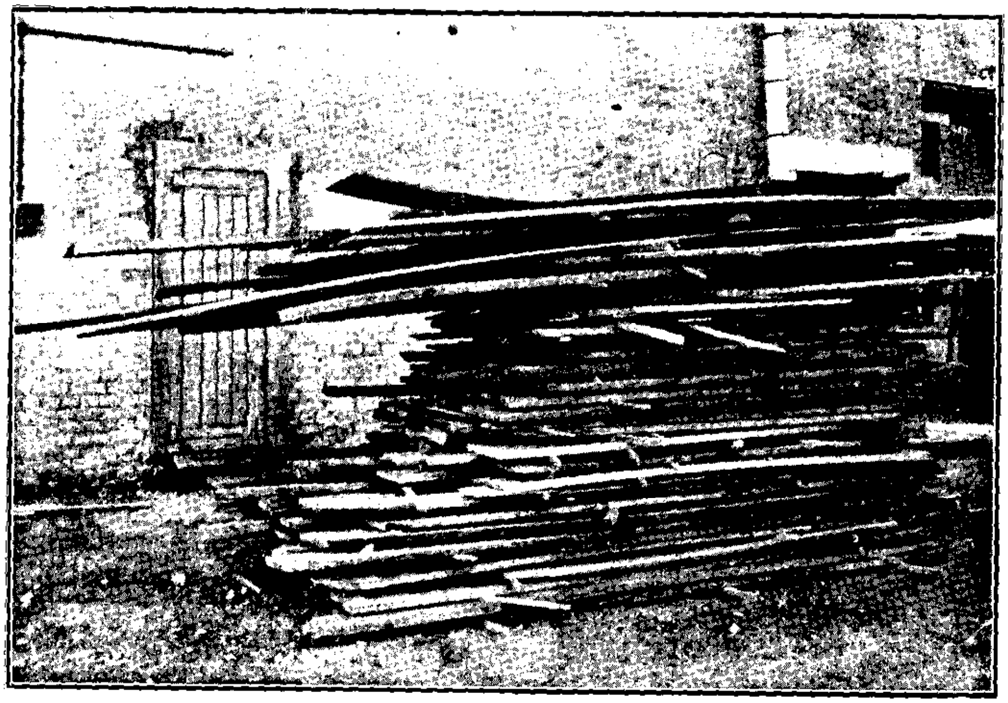


Fig. 1. A consignment of timber stacked by men who did not know their job.

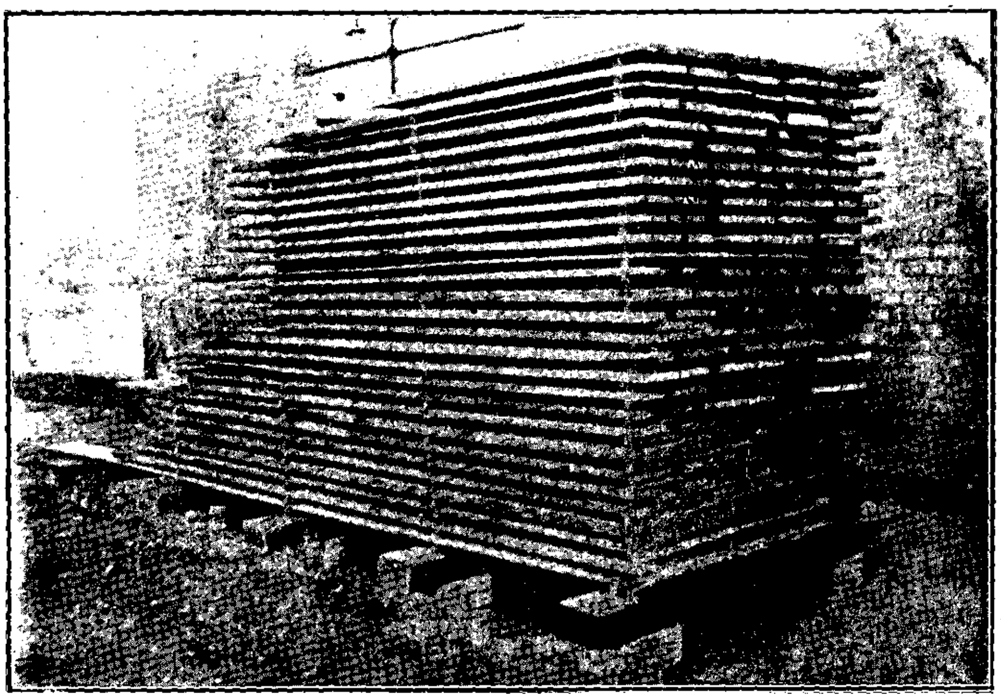


Fig. 2. Exactly the same timber as that shown in fig. 1 stacked by men who DID know their job.

in between the upper and lower cross-bars in several layers, so that they lie in a more or less rigid mass parallel to and between the two floats; they are then conveyed to the sawmill at Bandon as previously described.

I am indebted to some of the staff of the East Asiatic Company for their kindness in supplying me with a lot of the information given above, and also for a sketch showing the plan and elevation of the floats which I send herewith. I also send a small snapshot of a pair of floats in the river at Tha Mai Lium which has unfortunately not come out very well.

D. BOURKE, I.F.S.,
Adviser,
Forest Department, Siam.

EIGHT ANNAS MORE.

You can save money *(for the moment) by doing work in* a slipshod way.

The two photos show a parcel of timber, in the first case piled up in a slipshod manner, just as it *came off the* lorry, short and long, mixed; in the second case, the same timber re-piled properly after sorting to size.

In the second case, it took about an hour to sort out all the planks to length, but once this was done the stacking was rapid. All the long *lengths are at the bottom, dressing is* vertical at one end, and the piling sticks are correctly lined. And all this cost just Eight Annas More than the piling shown in the first photograph.

As a profitable investment I can recommend timber handlers in India to spend those eight annas.

If planks are put up to season in the state shown in the first photo a very big proportion of the wood will be spoilt due to excessive *splitting*, cup and warp. Even with *the* commonest wood and a deterioration of 20 per cent. only, the value of this loss will be twenty times eight annas.

In other words an *investment* of eight annas earns sixteen rupees in one year!

A picture of badly stacked timber is easy to get—go into almost any timber yard where sawn logs are stored. I am confident that examples will not be lacking.

An illustration of correctly piled planks generally evokes comment such as " anybody can stack good square edge lumber but you should see the rubbishy mixture, etc., etc."

Listen! (as the Americans say). The timber in these two photos was the same, stick for stick, and the only difference was that eight annas more care was used in the second case.

Information about stacking and the fine results obtainable by using care, is given in Forest Record, Vol. IX, Part V, and on any particular case the Forest Research Institute, Dehra Dun, will be only too pleased to give advice.

As a general rule—timber should be stacked so that every board is flat and under no bending stress. The piling sticks should be in line one above the other and the weight of the pile then keeps everything flat—if they are otherwise the boards are bent and dry out curved. As one cannot get all planks of even length it must be arranged so that all the long planks are below, then the medium (or two short) above them and so on up the pile. In this way there are no over-hanging board ends and consequently no bending or warping.

If the stack is not in the godown but in the open, protection must be given from the excesses of the climate with a thatch over the top and a protection from wind if the timber is of a refractory type. Such protection can be given by a side shade made of bamboos and plastered mud.

The direction of the prevailing wind should be studied. It is bad to have wind on the ends of planks as these overdry while there is stagnation in the centre of the pile. The ventilation should be across and through the pile and not against the end.

STANLEY FITZGERALD,
Officer in Charge, Seasoning,
Forest Research Institute,
Dehra Dun.

THE ARTIFICIAL DEVELOPMENT OF SPOROPHORES OF *POLYPORUS GILVUS* (SCHW.), FR. & PAT.

Last year the writer contributed a note* on *Polyporus gilvus* as a suspected root parasite of *Shisham (Dalbergia Sissoo)* in Dehra Dun. Since then the fungus has been under constant observation and the study of its life-history is being continued together with that of *Ganoderma lucidum* and a species of *Fusarium* with which it is often found associated. Inoculations with pure cultures have been made but it is not proposed in this paper to deal with the results, so far obtained, but merely to record the method adopted in growing sporophores of *P. Gilvus* in artificial culture.

On April 25th, 1924, a few pieces of the sapwood of *Shisham,* which were infested with the characteristic rot of *P. gilvus* were collected from the base of a dying tree which had developed sporophores of *P. gilvus* during the previous rains. After a microscopic examination spots which contained living hyphæ were located and three slabs were cut out from such areas. The hyphæ were hyaline or pale coloured, septate and provided with clamp connections which left no doubt as to their family identity. The slabs were then sterilised by the alcohol-flaming method and put inside sterile potato tubes. Next day a white mycelial growth appeared on all the slabs but it was not fit for transfer. After 48 hours the mycelia made satisfactory progress but the general appearance of the growth was not alike in all the tubes particularly in No. 3. One subculture from each tube was at once made on Glucose Agar. At the same time a microscopic examination of the hyphæ was made from the original potato tube material and it was found that slabs Nos. 1 and 2 were over grown by a *Fusarium* which had already fructified copiously It was therefore not possible to isolate the fungus from these The 3rd slab, however, appeared to be free from contamination and contained the same type of hyphæ as originally observed in the *shisham* wood.

Three days later the Agar Agar subcultures were also examined microscopically and, as expected, the cultures ob-

* Indian Forester, Vol. XLIX, 1923, p. 503.

tained from slabs Nos. 1 and 2 were a mixture of *Fusarium* and the *Basidiomycetes* hyphæ while that of the third tube was apparently pure and consisted of the latter form of hyphæ only. Having thus established a pure culture it became necessary to find out whether these hyphæ really belonged to *P. gilvus* or to some other fungus of the same group. The best way to determine this was to grow them on slabs of *shisham* wood and induce them to fructify. For this purpose a dozen slabs were prepared from diseased and from healthy sapwood of *shisham* roots. All these slabs were put in potato tubes and sterilised in an autoclave at 125°C for one hour and twenty minutes which rendered them perfectly sterile. They were inoculated with mycelium as follows:—Nos. 1, 2, 3 healthy sapwood from *shisham* root, Nos. 7, 8, 9 decayed sapwood of *shisham* root, Nos. 4, 5 and 6 were similar to Nos. 1, 2 and 3 and 10, 11 and 12 similar to 7, 8 and 9. These were not inoculated but kept as controls.

The idea of using decayed wood as a culture medium was based on the observation that in nature this fungus has been found to fructify only after the rot has reached a certain stage. It has been repeatedly experienced while working with this fungus as also with *Ganoderma lucidum* that slabs of healthy *shisham* wood when inoculated with pure cultures have never succeeded in producing artificial sporophores. This is perhaps, due to the hyphæ not growing sufficiently into the wood to bring about the necessary change required for the development of fruit bodies. It was therefore thought that a trial with decayed wood, after a thorough sterilisation might produce successful results.

After 48 hours an uniform aerial growth of hyphæ was seen on the inoculated slabs but by the 5th day slabs Nos. 1, 2 and 3 had made decidedly more copious growths than 7, 8 and 9. One slab of each series, Nos. 1 and 7, was examined a little later and found to contain typical *Basidiomycetes* hyphæ closely resembling those of the pure cultures.

On slabs Nos. 8 and 9, twenty-four days after inoculation, a few thin yellowish crusty spots were observed which looked, as if they were an indication of early sporophore formation,

but owing to comparatively dry weather having set in by this time the growth gradually slowed down and ultimately appeared to have completely stopped in all the tubes. Slabs No. 2 and 3 showed more or less the same condition except that they had no sign of the yellowish crusty spots and the fluffy mycelial growth sank down and formed a thin filmy cover over them. This is the stage at which the cultures usually fail. In the absence of an incubator to provide a warm humid atmosphere for the growth of cultures, a wide mouthed stoppered bottle was used in which the cultures and the control tubes were placed. The bottle received the early morning sun every day for about a couple of hours through the glass panes of a window. The temperature inside the bottle appeared to have been raised as was evidence by the condensation of drops of water on the walls of the bottle. The change thus brought about in the air within renewed the growth in slabs No. 8 and 9 and the yellow patches previously noticed on them began to grow further and ultimately assumed a definite shape and colour and developed small pores on the exposed surface. A little later spores were also formed. The resupinate form seems to be due to the position assumed by the sporophores on the slab but a rudimentary bracket formation was noticed in some sporophores. Fig. 1, plate 15, shows slab No. 8 with fructifications on its surface, and a portion of the same more highly magnified.

A further attempt will be made to induce the production of the bracket form of fructification.

The control slabs remained perfectly sterile up to the end of the experiment.

A. HAFIZ KHAN,
Assistant to Forest Botanist.

THE YIELD IN U. P. *SAL* FORESTS.

In the September number of the *Indian Forester*, 1924, pp. 481—485, we reviewed some recent working-plans of the United Provinces including that of the Dehra Dun Division. The origi-

nal yield fixed for the Thano Working-Circle of that Division was 116,200 cu. ft., which we suggested should be reduced by, 15 to 20 per cent., *i.e.*, to a yield of from 92,960 cu. ft. to 98,770 cu. ft. We understand that the actual yield now adopted is 100,000 cu. ft.

Mr. C. G. Trevor, Conservator of Forests, Working Plans Circle, U. P., has kindly brought to our notice the following memorandum on the methods employed in calculating the yield.—HON. ED.

MEMORANDUM ON THE CALCULATION OF THE YIELD OF THE THANO WORKING CIRCLE.

1. Paragraph 116 gives details of the growing stock, the ages adopted from yield tables and the corresponding M. A. I. For the purpose of the following calculations the mean between quality classes II and III is adopted and the following ages employed :—

Diam. class	8″ — 12″	= 56 years.
	12″ — 16″	= 74 „
	16″ — 20″	= 96 „
	20″ and over	= 129 „

The age of the 8″ diameter tree is taken at 37 years. Deducting this figure of 37 from the ages of the above diameter classes the mean age of the diameter class over and above the age of 8″ tree is given in column 6 of the table in paragraph 122. As the volume in column 5 excludes everything under 8″, so the *ages in column 6 exclude the age of the 8″ tree or 37 years.*

2. The mean age of the crop in column 7 is obtained from Andre's formula as follows :—

Let a_1 a_2 a_3 be the ages of several age classes.

n_1 n_2 n_3 the number of trees in the several age classes.

$$\text{Then the mean age} = \frac{n_1 \times a_1 + n_2 \times a_2 + n_3 \times a_3}{n_1 + n_2 + n_3}.$$

Substituting the figures in columns 3 and 6 the formula is—

$$\text{Mean age} = \frac{24 \times 19 + 14{\cdot}6 \times 37 + 5{\cdot}3 \times 59 + 1{\cdot}9 \times 92}{24 + 14{\cdot}6 + 5{\cdot}3 + 1{\cdot}9}$$

$$= \frac{456 + 450 + 313 + 175}{45{\cdot}8}$$

$$= 32{\cdot}4.$$

The M. A. I $= \dfrac{\text{Volume}}{\text{Age}} = \dfrac{906}{32{\cdot}4} = 28$ cubic feet

and the yield by Heyer becomes

$Y = \text{M. A. I.} \pm \dfrac{Gr - Gn}{r}$ where Gr = real growing stock.

Gn = normal „ „

r = rotation.

Gn has been calculated from the yield table to be 1,193 cubic feet and $r = 96$ years.

$\therefore Y = \dfrac{28 \pm 906 - 1{,}193}{96} = 28 - 3 = 25$ cubic feet.

3. This is the yield given in the plan. It may be argued that it is wrong to deduct the age of the 8″ tree. In this latter case M. A. I. may be obtained by dividing the actual M. A. I. 52,502 cubic feet as given in paragragh 116 by the area 4,650.

In this case M. A. I. $= \dfrac{52{,}502}{4{,}650} = 11$

or proceeding with Andre's formula

$$\text{Mean age} = \frac{24 \times 56 + 14{\cdot}6 \times 74 + 5{\cdot}3 \times 96 + 1{\cdot}9 \times 129}{24 + 14{\cdot}6 + 5{\cdot}3 + 1{\cdot}9}$$

$$= \frac{1{,}344 + 1{,}080 + 508 + 245}{45{\cdot}8}$$

$$= \frac{3{,}177}{45{\cdot}8} = 69$$

$\therefore$ M. A. I. $= \dfrac{\text{Volume}}{\text{Mean age}} = \dfrac{906}{69} = 13.$

Then the yield by Heyer's formula is say,

$Y = 13 - 3 = 10$ cubic feet.

As will be shown later on this is an absurd yield and it is not correct to calculate the M. A. I. on the volume of trees above 8″ and at the same time not to adjust for the age of the 8″ tree when using this formula.

4. Calculating the yield by Von Mantel, page 101, Practical Forest Management, and page 75, American Forest Regulation.

$Y = \dfrac{2V}{r - x}$ where $r = 96$

x = age of 8″ tree = 37.

$= \dfrac{906 \times 2}{96 - 37} = \dfrac{1{,}812}{59} = 30$ cubic feet.

Even if the above modification were *not* adopted and only $\frac{2V}{r}$ taken, the *yield* becomes 18 cubic feet.

5. *The yield by* Hufnagl will now be considered, for this it is necessary to know the volume of trees half the rotation and over and their increment. Turning again to the table in paragraph 116, it will be seen that all the diameter classes enumerated average over 48 years. The 8" trees are less than 48 years, but to compensate for this a number of trees below 8" will in due course come into the 8"—12" diameter class and be included in the yield. In any case, for the purpose of this calculation the whole growing stock enumerated will be considered to be $\frac{r}{2}$ years and over in age. In paragraph 3 the mean age has been calculated at 69 years and a reference to curves Nos. 4 and 8 will show that for mean II/III quality at the age (excluding establishment) of 59 years the C. A. I. = 37 cubic feet on a standing volume of 2,000 or 1·85 per cent, which on a volume per acre of 960 = 16 cubic feet per acre. However, it will suffice if we merely take the increment as the same as already calculated for P. B. I of the Sal Working Circle, *i.e.*, 1·40 per cent., this gives a C. A. I of 12 cubic feet which is seen to be midway between the two M. A. Is. calculated in paragraph 3.

The yield now becomes—

$$Y = \frac{V + \left(i \times \frac{r}{4}\right)}{\frac{r}{2}}$$

$$= \frac{906 + (12 \times 24)}{48}$$

$$= \frac{1{,}194}{48} = 24{\cdot}8 \text{ cubic feet.}$$

6. Summarising the various yields calculated the following results are obtained on the 4,650 acres :—

(1) Working plan, paragraph 122—Heyer—adjusting mean age of crop by deduction of age of 8" tree ... = 116,200 c.ft.

(2) Using same formula unmodified $4{,}650 \times 10 = 46{,}500$ cubic feet.
(3) Von Mantel, using $r—x$. $4{,}650 \times 30 = 139{,}500$ „
(4) Von Mantel, using r unmodified $4{,}650 \times 18 = 83{,}700$ „
(5) Hufnagl, using C. A. I as 12 cubic feet
$4{,}650 \times 24{\cdot}8$ ... ... $= 115{,}320$ „

The above figures show that there is nothing wrong in making the adjustment as in example (1) above as has been done in the plan, (2) is obviously wrong as it only gives about half the yield of example, (4) which is also too low. Example (3) is higher than (1) and (1) and (5) are very much the same.

7. It may be said that none of these formula methods are reliable. There is sufficient information to calculate the yield of P. B. I in the usual way and an investigation of the proportions between the main fellings and the intermediate fellings in other working circles show that these approximate one-third the volume of the main fellings. The yield of the regeneration area of the Thano Working Circle therefore becomes—

$$Y = \frac{V + (i \times \frac{p}{2})}{p}$$

where $V = 1{,}191{,}972$
$i = 1{\cdot}4$ per cent.
$p = 20$
$Y = 67{,}942$ cubic feet.

To this must be added the intermediate yields, *viz.*, one-third of the above, which brings the total yield of the working circle to 90,589.

C. G. TREVOR,
Conservator of Forests,
Working Plans Circle, United Provinces.

TWO EMINENT FOREST OFFICERS.

Indian Engineering devotes its leading articles on April 19th and 26th and December 27th, 1924, to appreciative notices of the excellent work done by Sir William Schlich and Sir Sainthill Eardley Wilmot in connection with forestry in India and Great Britain.

4

AN AMERICAN TEXT-BOOK OF FORESTRY.

ELEMENTS OF FORESTRY—By FRANKLIN MOON, B.A., M.F., Dean, New York State College of Forestry at Syracuse University, and NELSON COURTLANDT BROWN, B. A., M. F., Professor of Forest Utilisation, New York State College of Forestry at Syracuse University. Second edition revised and reset. New York, John Wiley & Sons, 1924, 409 pages. Price 17*s*. 6*d*. net.

In their preface to this edition the authors state that to keep abreast of a subject which has been developing as fast as the science and art of American Forestry is a difficult task. The continued progress and expansion of the Conservation movement in America can be assured only through cumulative popular education which must reach every group and class, and must pay particular attention to children in the schools and to students in Agricultural Schools and Colleges. The large number of Forestry text-books, which have appeared within recent years, deal as a rule with one phase or speciality. The object of the authors has been to prepare a book general in scope, and to present the information in a form easily grasped by the average student.

The work traverses the whole subject of Forestry. It gives a short account of the meaning and importance of Forestry, Silviculture and Silvicultural systems of Management, Forest Protection, Forest Mensuration, Lumbering Wood Utilization, Wood Preservation, Forest Economics and Forest Finance. Additional chapters deal with the activities of the United States Forest Service, while the work concludes with descriptions of the different forest regions found in the United States.

This book may perhaps be criticised best from two different standpoints, one being its value to the student of Forestry and the other its value as a popular educational work.

From the former standpoint the book appears to possess little value. As the whole subject of forestry is traversed in the course of 273 pages of medium type it can be realised that only the fringe of the subject is considered. Working plans are dismissed in the course of three short paragraphs! Further the

actual information given whether true or not in respect of American Forestry—and it is hoped that it is untrue,—is liable to mislead the general student. The silvicultural systems as described constitute exploitation systems and nothing more. The selection system—which in real forestry demands the most intensive skill of any system—is stated to require less skill than any other system! The shelterwood system is described as a highly theoretical system of management which is rarely employed even in Germany and France, demands the most favourable economic conditions for its successful application, and will not be used for a long time in America. We are also informed that improved works such as cleanings "should be postponed until the material is at least large enough to pay the expenses of removal." If such remarks are truely applicable to American forestry conditions it can only be said that forestry practice in America lags a long way behind that in India and that we forest officers in India have progressed infinitely faster under more or less similar difficulties than our American cousins.

Against the definitions of Forestry can be taken exception to. Forestry is defined as "the art of producing in perpetually the maximum yield of timber and other forest products from non-agricultural soils." This is a much narrower interpretation than forest officers in India would put on the subject. What about protection forests? Further it is stated that the first characteristic of a forest is that "the crowns must meet so as to produce a certain amount of shade." Yet it is also stated that the supply of grazing grounds constitutes the most important business in many of the national forests. How forests with crowns meeting satisfy grazing necessities is not explained. Further statements difficult to reconcile are that to secure good natural reproduction vigorous middle aged trees should be left while later on in the book it is stated that natural regeneration is cheap to obtain as it involves only the leaving of old or defective trees as mother trees.

From the general forest student's point of view the most interesting part of the book is the regional studies in which a concise description is given of forest conditions in the various

forest regions of the United States. Although condensed these descriptions convey an interesting idea of the nature of the forests possibilities of development, and problems to be faced. How far the conclusions given are sound it is not possible to say but to take one instance the remark that the treeless condition of the prairies is probably due in the main to repeated grass fires appears to ignore the evidence of plant geographical studies.

From the standpoint of popular education in forestry matters the work is likely to be more serviceable as it does convey an idea of the objects of Forestry and the value of its practice to the American nation. At the same time judged from this standpoint only the work could, it is considered, have been abbreviated with advantage by omitting many of the statistics which are included. Further, forestry terms such as 'tolerant' are referred to before they are explained. However if the work does succeed in enlisting in the cause of forestry a few more general public supporters it will have served a useful purpose and the authors may be congratulated on having assisted one of the most deserving, if ill-understood, causes in the world.

The work is well printed and illustrated with some excellent photographs.

J. W. N.

A BACTERIAL DISEASE OF THE CRICKET BAT WILLOW.

THE WATERMARK DISEASE OF THE CRICKET BAT WILLOW —*Salix caerulea*—by W. R. DAY, B.A., B.SC., Mycologist, Oxford Forestry Memoirs No. 3, 1924, Oxford Clarendon Press, pp. 30, figs. 17. Price 3*s.* 6*d.* net.

The author describes his investigations on a disease which has recently forced itself on the notice of willow growers in East England. As is usual in tree diseases the primary cause was not obvious, fungi being often present which were not responsible for the damage. It is shown fairly conclusively that the causative agent is a bacterium. The author proposes "provisionally" to call it *Bacterium salicis.* It is not apparent why he emphasises

that the name is only "provisional." If he is not satisfied that the organism is new he would do better to leave it unnamed whereas if satisfied that it requires a name he would go further towards convincing others that the species is new if he showed that he was satisfied himself and put forward the name unequivocally and accompanied by a Latin diagnosis. A name put forward tentatively without a valid description is of no use if question of priority subsequently arise.

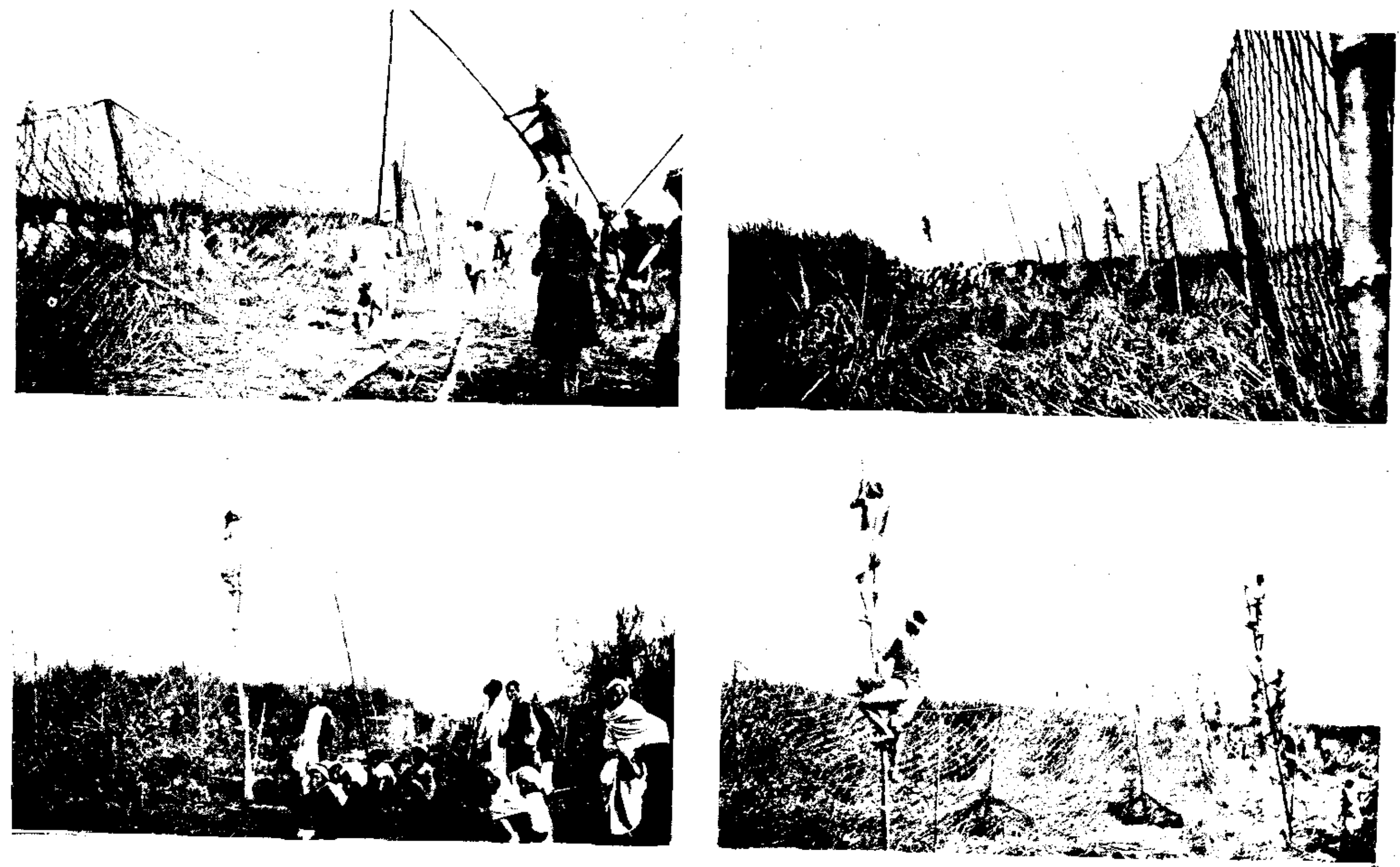
Of greater interest to Indian Foresters than the name of the causative agent are the remedial measures proposed. It is becoming more and more evident that fungi become of serious forest importance almost solely when conditions are not entirely favourable to their host. At the recent Imperial Mycological Conference more than one speaker pointed out that diseases of sugarcane, tea, etc., could be controlled by attention to soil conditions. Hence it seems probable that the recommendation not to plant willow on soil the sub-soil of which is wet and sodden, will prove more efficacious if acted upon than all the other suggestions combined excluding the obvious one not to plant cuttings already infected.

The author makes no mention of the possibility of certain strains of willow proving immune, but as he states that sometimes badly infected trees cease to die back it seems quite possible that a race of willow could be found highly resistant to the disease. Such a strain would be valuable should the disease prove refractory to general hygenic control measures.

It is not quite evident what the author has in mind when he says "No other such disease of trees appears to be recorded with the result that the vascular bacterial diseases of herbaceous plants are the only ones with which comparison can be made." The disease shows a great many resemblances to Fire Blight of Rosaceous fruit trees caused by *Bacillus amylivorus* (Burrill) Trev. In this disease an account of which is given by V. B. Stewart in Cornell University Bulletin No. 329, the wood vessels are sometimes completely blocked by masses of bacteria and many of the symptoms are strikingly similar, though fire blight is a disease of the cortex rather than of the wood.

The memoir is illustrated by numerous well chosen plates and the whole investigation seems to have been made by the author in a very thorough and creditable manner.

R. N. P.



TIGER HUNTING WITH NETS.

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HUNTING TIGERS WITH NETS.

Imagine immense alluvial plains with savannah tracts alternating with rice fields and open water bhils divided up into irregular lakes by marshy lands covered with reeds and grasses high enough to hide the largest elephant and you have the ideal home of the tiger. The high grass lands full of deer and cattle grazing in the rice stubble, afford him food and there is ordinarily more cover than he requires until the fire season sets in and the patches of grass get smaller and fewer. The season has begun in which the local villager sets off to net deer, the sambhur being his favourite quarry, but an extra troublesome tiger may also be netted should circumstances prove favourable. Vistas are made by pressing down the grass in a straight line; a tiger crossing such a vista is located by men on watch for him, after he has been quietly driven off his kill. We were fortunate enough to arrive to find that a tiger had been turned back at a net placed on the side of a vista which had been netted over a length of 100 yards or thereabouts; another party having formed a line at another vista which joined up two open areas towards which the tiger would not break.

Tiger netting depends for its success on the well-known attribute of a tiger that he will never come out into the open unless wounded or very hard pressed: Consequently any villager who jabs the intended victim hard with a spear early in the proceedings is heavily fined. The process of drawing the cordon round the tiger is interesting to watch and consists in

gradually demolishing his grass cover by pressing it down with the spears with which all the hunters are armed the grass pressers being protected by spearmen prodding the unpressed grass ahead while another posse of spearmen complete a hollow square walking backwards as the pressing goes forwards the spears pointing in every direction. This goes on until the nets are sufficient to enclose the whole area after which, if there is no demonstration, pre ssing is done just inside the net and the nets brought in first on one side and then on the other. On this occasion there was some delay in getting the nets and the circle was not complete till 8 P.M. when we went home, the area enclosed having a diameter roughly of about 100 yards. Watch was kept all night but owing to everyone's want of foresight there was hardly enough fuel to last out the night. The tiger had been making violent demonstrations at various points before we left. We turned up next day to find the nets drawn closer to the centre of the circle, the hunters being encouraged by the quietness of the tiger. Look outs stationed high up on stout bamboo ladders round the arena were able to see when and where the grass moved and to give warning to the net men in case the animal made a rush. The cordon being reduced to an area so small that pressing by hand became dangerous, resort was had to a log which was put inside the net and dragged through the grass. This revealed the fact that the tiger had escaped by worming his way under nets at some insufficiently guarded spot during the night and escaped. The modus operandi was interesting to watch and given a somewhat better bandobast the tiger might well have been bagged. There was no recognised leader and it struck the writer as wonderful that under the haphazard way everyone appeared to do as he thought fit, a tiger ever is brought to bag but several tigers are caught and killed by these means every year. It generally takes a week or more to give the tiger his coupe-de-grace and the actual log dragging is usually deferred until the last day by which time the tiger is weak from want of water and half drunk from want of sleep. In one instance a tiger was found actually to be dead from want of water.

This is the only practicable method of killing tigers in the vicinity. It would be very dangerous to beat tigers up to guns in heavy grass without any trees in which beaters could take refuge even if they had time. The grass is so dense that a tiger would most certainly get a beater if he broke back. It is obviously impossible to sit up in a sea of grass, a ladder machan would be visible to the tiger before he got to the kill and a pit would probably contain water. The nets used are of jute grown locally. They are about eight feet high and are strung on ropes running in notches made at the end of stout bamboos driven into the ground. Ropes are also used to brace the net work diagonally in a longitudinal direction and the posts prevented from falling inwards by being anchored to grass tussocks. The nets start by being single but as the cordon gets smaller they are doubled and even trebled. A single net could easily be burst through or thrown over but even a tiger could hardly manage to get through a treble net of stout cords on posts standing close together. The business is looked upon rather in the light of a tamasha and thousands roll up to view the grand finale which we hope to see one day. It was a study in contrasts while all the excitement and noise was going on to see in the far distance the mail train creeping up the valley and hear it rumbling over the bridge spanning the adjacent river.

F. T.

SOME NOTES ON NATURAL WOODS OF *CASUARINA EQUISETIFOLIA* GROWING AT SINGORA, IN SOUTHERN SIAM.

During August and part of September I made a rapid tour round parts of Southern Siam, that is, round the southernmost portions of the Malay Peninsula which lie within Siamese boundaries.

I started my tour by taking ship from Bangkok in a small coasting steamer of the Siam Steam Navigation Company, and proceeding down the eastern coast of the Peninsula to Singora which is the chief town in this part of Siam, situated geographically nearly due South of Bangkok. It is the headquarters of the Viceroy and a number of other local officials,

The town is a fairly small one, situated amidst beautiful tropical surroundings, on the southern shores of a creek, with a picturesque back-ground of hills, covered with dark ever-green forests. This creek, which is about 2 miles long and a quarter of a mile broad joins the Gulf of Siam north and south, and at its southern end it gradually opens out and turns northwards, forming the entrance to a remarkable inland sea called Tale Sap.

This inland sea is of irregular shape, winding about between large headlands and islands, stretching out to a total length of nearly fifty miles. Its eastern shore is separated from the Gulf of Siam by a long. narrow tongue of land, broken by one large headland.

The climate of this tract of country is warm, equable and very moist. Rain falls in most months of the year, but the east coast does not come under the influence of the south-western monsoon, the most rainy months being from the middle of September to the first half of January. The heat is much tempered by the pleasant sea breezes.

On arrival, I was interested to see for the first time natural woods of *Casuarina equisetifolia*, growing plentifully on both sandy shores of the creek and stretching out in narrow strips and belts along the seashore, and I was informed that similar woods grew at various places, all along the eastern coast, south of this place, though I did not myself visit them. The tree is common as a plantation tree in many parts of India proper, but does not occur naturally.

The late Mr. A. M. Burn-Murdoch in his pamphlet "Trees and Timbers of the Malay Peninsula" (Part II) states that the trees grow wild only on the coast of the Peninsula and that on the eastern coast a belt of this species stretches almost uninterruptedly for 100 miles along the shore wherever it is sandy, this belt being from 50 to 200 yards in width. This no doubt, refers to the F.M.S territories and not to the adjoining provinces of Siam, but in both, the conditions must be quite similar. He also advocates the theory that the real home of the tree is in Australia, and that as the seed is very small and light and produced in enormous quantities, it has been gradually carried by sea from Australia to Java, Borneo and other islands, and thence to the east coast of the

Peninsula, as it does not occur inland in the Peninsula, except where introduced. This theory however does not account for its natural occurrence on the west coast of the Peninsula, where it is found, in places where the sea coast is sandy.

Northwards of the town of Singora the seashore terminates in a narrow headland of pure sand over one mile long and about a quarter of a mile broad. The total area might be about 250 acres and it is completely covered with a beautiful wood of *Casuarina* trees, except for the last 200 yards or so, at the extreme northern end. The wood is fairly well stocked, though gaps in the canopy appear here and there, and it exhibits all the characteristics of its type, the ground being covered with a carpet of needles and bare of all vegetation, except that, here and there, a few sand-loving undershrubs appear.

It is evident, on inspection, that the age of the wood decreases steadily as one walks northwards, but as there are no written records nor observations of any sort, it is difficult to give precise information of any value, however I managed to obtain the following facts. About 700 yards from the extreme northern point there is a small fishing village and customs house, and nearby these there is a large square cement-concrete pillar which projects slightly above the surface of the ground. This pillar used to serve as the foundation or footing to a telegraph-mast conveying the line across the creek, but it has been in disuse for many years, now.

A Danish gentleman, residing in Singora for the past 19 years, informs me that 15 years ago he stood on this concrete pillar for 3 days in the course of marine surveying, taking observations ; at that time, there were no trees at all and no village, northwards of this pillar, so that he was able to observe freely in all directions.

It therefore follows that all *Casuarina* trees northwards of this point are likely to be less than 15 years old, so I measured the girths of 23 trees standing in a group immediately north of the concrete pillar and found the average girth at breast-height to be 42·4″. The heights of two trees, standing in the above group, were measured with a large marine sextant, and found to be 134′ and 127′ respectively, which gives an average height of

130·5′. As it is not possible to obtain any more accurate information, I give the above facts and the figures resulting from theory as related to me. The rate of growth, as recorded, is enormous and far exceeds anything that I have seen recorded in the plantations on the sea coasts of India proper. This, however, is only to be expected, as the *Casuarina* in India proper is an exotic, planted far away from its natural habitat, whereas, here, in southern Siam, it is growing naturally under much better conditions.

I see in Professor Troup's "Silviculture of Indian Trees," Volume III, page 907, that the mean girth of *Casuarina* plantations in North Kanara, Bombay Presidency, at 15 years, is 22·6″, and the mean height of dominant stems is 51′, it is also stated elsewhere in the book that, on the few occasions on which the *Casuarina* has successfully coppiced in North Kanara the rates of growth were much higher, coppice poles 13 years old attaining 36″ girth and over 80′ in height.

Proceeding northwards from the small above-mentioned village, the height-growth of the *Casuarina* steadily diminishes and much of the growing-stock consists of a thin wood of younger poles, with an average girth of about 24″, but between these there is an excellent growth of natural regeneration, in small groups, which is rapidly filling up the gaps, and finally, at the northern end, there is a narrow fringe of young seedlings and saplings, standing in small patches and as single plants, gradually encroaching on and spreading over the sands.

It appears, that in these parts the natural regeneration spreads slowly and with some difficulty, as the wind blows the seeds from the older trees, but as soon as the young trees are established their enormous growth soon converts the area into a thin pole-wood, and then, within this shelter-wood the blanks are very quickly filled up by groups of natural seedlings.

At the extreme south-eastern end of the woods, which I have attempted to describe above, there is a most remarkable grove of very old *Casuarina* trees, stretching for a short distance along the main coast-line. I estimated the area covered by these old trees, by pacing, to be about 25 acres. These trees are of great age and size and they have become quite unlike the ordinary type

Fig. 1. View of part of a *Casuarina* wood near Singora town, extending over about 250 acres.
Fig. 2. View of part of the grove of old *Casuarina* trees, near the Singora Club-house.
Fig. 3. Some of the large old *Casuarina* trees, near Singora Club-house.
Fig. 4. Natural regeneration of *Casuarina* spreading over the sea-shore.

Photos by R. Havmöller.

of *Casuarina* tree that one knows in India, being of a weird gnarled and weather-beaten appearance, and having mostly massive forked boles and huge spreading crowns. Most of the boles of the trees are very misshapen and deeply fluted, with several large, protruding buttresses at the base of the tree.

Walking down the centre of the grove, I measured 14 trees, that came into my path as I walked along, and found the average girth at breast-height to be 12′ 1⅛″; one tree measured 20′ in girth, another tree measured by me in another part of the grove had a girth of over 22′, and girths of 15′—20′ are not uncommon. These girth-measurements give some idea of the size of these fine old trees, moreover, in spite of their spreading stature, the height growth also is great, and the height of one tree, growing near the Singora Gymkhana Club house at the Southern end of the grove, measured with a large marine sextant amounted to 143′. Their age is unknown, but must evidently be great, and to all appearances, over 100 years. Residents in Singora for the past 20 years or so, state that there is absolutely no difference in these trees to when they first arrived in the place.

The sea, unfortunately, at this particular place, is eating into the coast, year by year, and, slowly but surely, these giants are being destroyed, one by one. Unless some protective measures are taken in hand in the future, most of them, in the long run, will be undermined and overthrown. This old grove and the adjoining *Casuarina* woods north of it, are not in charge of the Forest Department, but the local Revenue Administration protects them for aesthetic reasons, from damage by the local population.

The great economic value of *Casuarina* wood as a fuel is well-known in many parts of India, and I see that the late Mr. A. M. Burn-Murdoch states that it is said to be the best firewood in the F. M. S., better even than mangrove fuel. On the coasts of Southern Siam, however, it has little economic value for anything, not even for fuel, for all kinds of fuel, as a rule, are superabundant. I have seen it growing on the sandy beaches of the western coasts and have been told that it is used for fishing-stakes in those parts. On the eastern coast the local people use

a certain amount of the poles for building sheds and shelters and they also do cut it for fuel. They are so indolent in their methods that they don't bother to fell each tree singly and then convert it into fuel billets, but they hack and lop at crowns of the standing trees, more and more heavily, until they eventually kill them, leaving the mutilated "corpses" standing about all over the sea-shores.

D. BOURKE, I.F.S.

SOIL CONDITIONS UNDER *SAL*.

Plant growth is intimately related to the conditions prevailing in the soil. So far as the regeneration of *sal* is concerned, Mr. Hole has observed that the primary factors which control the development and growth of seedlings in a particular soil are the aeration and the moisture-content of the soil. These two factors control the bio-chemical changes going on within the soil, which in their turn affect the growth of plants. Bad aeration of soil results in the accumulation of carbon dioxide and deficiency of oxygen in soil-gases and consequently the roots become unhealthy and the plants sicken. Mr. Hole is further of opinion that seedlings often die in shady *sal* forests because the air supply in the soil is deficient during the rainy season. From the results of his experiments he concludes that in an average *sal* forest loam, under natural conditions of rainfall, percolation and evaporation, an air-space of less than 452 cubic inches per cubic foot of soil, or 26 c.c. per 100 c.c. of soil, is extremely injurious to *sal* seedlings. Deficiency of water in the soil also causes widespread damage to seedlings and, provided other conditions are satisfactory, seedlings will develop normally when the moisture in the soil does not fall below 3 per cent. in sand and 10 per cent. in loam.

It may be mentioned here that the experiments of Prof. Troup and Mr. Hole show that accumulation of dead leaves on the surface of forest soils has a deleterious effect on germination. The cover of dead leaves separates the seeds from the reserve of soil moisture and obstructs the passage of the radicle into the soil.

An investigation was undertaken to study the soil conditions associated with the growth of *sal*. Mr. Hole has suggested that the best means of determining the conditions of soil-aeration is the analysis of soil-gases, and for this purpose an easy and practical method of extracting gases direct from forest soils should be devised. (*Indian Forester*, Vol. XLIV, pp. 208.) An apparatus has therefore been employed in these experiments which has satisfactorily answered the purpose. The observations were carried out partly at the experimental garden at Chandbagh, Dehra Dun, and partly at the Lachiwala Forest Range of the Dehra Dun division.

EXPERIMENTS AT CHANDBAGH, DEHRA DUN.

Two small plots under *sal* (15 ft. x 15 ft.) were laid out. The trees are now 14 years old. They were raised from seed and coppiced when about 2 years of age. The tallest stems are now 40 ft. in height. In one of these plots the ground was kept clean and in the other dead leaves were allowed to accumulate.

The soil-gases were extracted by means of an apparatus shown in the diagram on page 244. A wrought iron tube was first driven into the soil up to the required depth. It was then taken out and into the hole thus made another iron tube A of slightly wider outer diameter was pushed in. A loosely fitting iron rod B was next introduced into the tube to reduce the dead space. The tube was then connected to the manometer C and the gas sampling tube D; by lowering the mercury reservoir a vacuum was created in the apparatus and the soil-gases were sucked in. Air originally filling up the apparatus, was rinsed out with soil-gases before final collection was made. The analysis of the gases was carried out in the usual way.

Samples of soils at 3" to 6" and subsoils at 15" to 18" were also collected and determinations of moisture (loss at 100° C) organic matter (loss on ignition) organic nitrogen (Kjeldahl) and nitrogen in nitrates were made. Mechanical analyses of composite samples of soils were also carried out. The volume of water-free air-space per 100 c.c. of soil was calculated from the weight of a known volume of soil in situ, taking the average density of the mineral constituents of soils as 2·65 and that of the organi matter as 1·2. The results are abbreviated in tables I and III.

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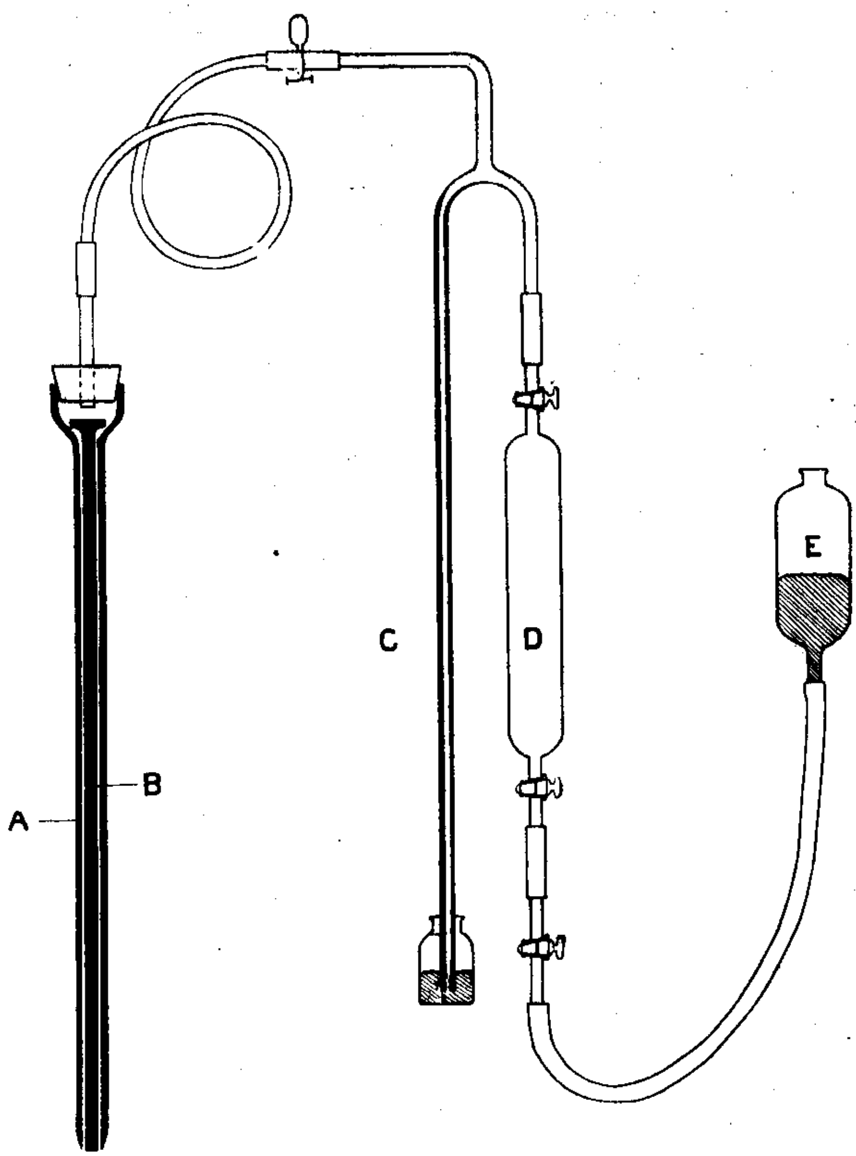


It will be noticed that during the rains (July to September) the soils were more or less saturated with water and contained only a small amount of free air-space; the soil of the cleared plot containing a larger amount of air-space than that of the plot with a leaf-cover.

As the rainfall decreased the soils began to lose moisture, the surface soil drying more quickly than the subsoil. As was expected, the plot with a leaf-cover parted with moisture more slowly. With the loss of moisture during the subsequent dry seasons there was an increase in the amount free air-space, but it was only in December that these soils contained such a sufficiency of air-space as was considered by Mr. Hole to be above the safety limit for *sal* seedlings. The composition of the soil-gases also varied with the season. During the rains the soil-air differed from the atmosphere-air in containing a very high percentage of carbon dioxide and a low percentage of oxygen. It was noticed that the gases from the cleared plot contained a much higher percentage of carbon dioxide and a lower percentage of oxygen than those from the plot with a leaf-cover. With the close of the rainy season, the soil-gases approached atmospheric air in composition.

It is also interesting to note that the entire area of the plot with a leaf-cover was found to be thoroughly infested with white ants in December. The incidence of attack by white ants was no doubt an important factor in soil-aeration.

The seasonal variation of nitric nitrogen was interesting. It seemed to be associated with the rainfall in the cleared plot. In the surface soil of this plot nitric nitrogen rose from 0·26 part per million in July to 0·96 part in September and to 1·11 part in December. On the other hand, it followed a reverse course in the plot with a leaf cover. It fell from 3·34 parts in July to 1·31 part in September and to 0·87 part in December. It is not, however, permissible to draw general conclusions without collecting further data.

Experiments at Lachiwala, Dehra Dun Division.

Some experiments were also carried out at Lachiwala and thanks are due to the Divisional Forest Officer, Dehra Dun, who kindly afforded facilities for this work.

Four plots were laid out. Plot No. 1 was under simple coppice of *sal*. Plot No. 2 was selected in the grass area at Zabbarkhet. Plot No. 3 was under *sal* which, last year, was subjected to P.B.I. fellings for conversion to regular high forest

Plot No. 4 was in an area where strip felling had been made several years ago under the direction of Mr. Hole. The strip had subsequently been sown over and tended, resulting in a young crop of *sal* seedlings. Thanks are due to Mr. Kanjilal for help in the selection of the plots.

A plot was also selected from an area which was regularly fired, but owing to the presence of a large amount of stones and boulders in soil, it was exceedingly difficult to collect samples from this plot. One set of observation was however made in September. Results of observations made in these areas have been abbreviated in tables II and III.

As in the case of Chandbagh soils these soils also became more or less saturated with water during the rainy season and contained very little of free air-space. Plot No. 2, situated as it was in the lowlying area at Zabberkhet, remained absolutely waterlogged at a depth of about 8 inches during July and August. With the close of the rains Lachiwala soils, unlike Chandbagh soils, were losing moisture very slowly. Even as late as January these soils retained a considerable amount of moisture. In this respect particular mention may be made of Plot No. 3 (conversion felling) and plot No. 4 (strips). The moisture content of these two plots remained practically constant during the period of observation (July to January). This retention of moisture in these soils resulted in a comparatively slow increase in the amount of free air-space, and Mr. Hole's standard of limit of safety for *sal* seedlings was not attained even in January.

During the rains gases extracted from these soils also contained a very large excess of carbon dioxide and a very small amount of oxygen. As the rainfall ceased there was a recovery in the oxygen content. But in plots No. 1 and No. 4 the subsoils retained a fair amount of carbon dioxide even in January.

From the results of one set of observations made in the fired area it appears that the soil is less retentive of moisture; and even as early as September, the amount of free air-space was above the limit of safety for *sal* seedlings. This soil was better in texture than other Lachiwala soils in so far that it

contained a larger proportion of sand, stones and boulders This difference in the quality of the soil may account for its better aeration, and hence no definite conclusion could be arrived at about the influence of fire on forest soils. Further investigations are necessary to elucidate this point.

Reverting now to the composition of gases within the soil, t may be remarked that the amount of carbon dioxide and oxygen in the soil-air is closely related to the well-being of the roots of trees. Roots of different species vary in their tolerance of carbon dioxide and their response to oxygen, distribution of the root system and of the zones of root absorption during the life of the plant proving to be important factors in this respect (Cf. Howard, "The Effect of Grass on Trees," Proc. Roy. Soc. B., Vol. 97, 1925, pp. 284 et seq.). The results of pot culture experiments of Mr. Hole with *sal* seedlings show that accumulation of carbon dioxide and decrease in oxygen in the percolation water make the roots of the seedlings unhealthy. Reviewing the results of the present investigation, it is noticed, that during the rains, the soil-gases contained an excessive quantity of carbon dioxide and a low amount of oxygen, and the volume of free air-space was also very small. With the decrease in rainfall an improvement was noticed both in the quality of the soil-gases and in the amount of free air-space. In the case of Chandbagh soil it was in December that the amount of air-space was above Mr. Hole's standard of limit of safety for *sal* seedlings. But the Lachiwala soils did not attain this limit even in January. Thus it would appear that the conditions prevailing in these soils, specially during the rains, are not suited for healthy growth of plants, particularly of seedlings. The fact that hardly any recent seedling was noticed in these areas lends support to the above conclusion.

However as the present observations extended only for a short period, and as the rainfall was excessive during the season, it is not permissible to draw any general conclusion. A further detailed investigation is necessary to elucidate the individual effect of various factors involved in the growth of *sal* and their interaction on each other.

The writers take this opportunity of expressing their thanks to Mr. R. S. Hole, C.I.E., at whose suggestion this work was taken up. They also acknowledge the help which has been rendered by Mr. Brahma Shankar, B.Sc., during this work.

JATINDRA NATH SEN
and
TARAK PRASAD GHOSE.

TABLE I.—CHANDBAGH SOILS.

		Cleared Plot.						Plot with a leaf cover.					
		5th August.		17th October.		1st December.		5th August.		17th October.		1st December.	
		3"—6".	15"—18".	3"—6".	15"—18".	3"—6".	15"—18".	3"—6".	15"—18".	3"—6".	15"—18".	3"—6".	15"—18".
Gas ...	Carbon dioxide %	11·0	12·5	2·6	...	0·2	...	4·2	5·2	1·5	...	No samples taken white ants present.	
	Oxygen %	10·5	8·7	17·6	...	20·0	...	13·1	10·8	19·0	..	...	...
In grams per 100 grams of dry soil.	Moisture %	25·2	28·4	21·8	24·5	11·7	18·3	28·1	29·1	22·7	30·0	13·9	22·9
	Organic matter %	6·0	7·2	4·9	5·9	5·3	6·2	6·8	7·5	5·2	6·6	5·8	7·1
Water-free air-space (in c.c. per 100 c.c. of soil in situ).		14·5	8·0	18·9	10·1	31·4	17·0	9·4	6·1	12·9	10·1	26·8	12·0

N.B.—The blank spaces where no entries are made as to the composition of soil gases indicate that it was difficult to get samples in these instances.

TABLE II.—LACHIWALA SOILS.

		1. Coppice.						2. Grass.					
		25th July.		20th September.		14th January.		25th July.		20th September.		14th January.	
		3″—6″	15″—18″	3″—6″	15″—18″	3″—6″	15″—18″	3″—6″	15″—18″	3″—6″	15″—18″	3″—6″	15″—18″
Gas ..	Carbon dioxide %	8·6	...	9·4	...	1·4	3·9	1·7	Water logged.	3·7	0·4	0·5	...
	Oxygen %	9·4	...	11·0	...	19·2	16·0	9·2	...	16·5	19·8	20·1	...
Calculated on dry soil.	Moisture %	36·4	24·7	25·8	26·1	25·1	23·9	33·2	...	34·5	30·5	29·7	25·7
	Organic matter %	8·6	7·2	6·0	6·1	6·1	6·0	7·3	...	4·3	4·4	6·3	6·6
Value of water-free air-space in c.c. per 100 c.c. of soil in situ.		6·6	5·9	10·6	7·6	9·1	20·3	3·2	...	13·6	11·5	14·7	15·0

N.B.—The blank spaces where no entries are made as to the composition of soil-gases indicate that it was difficult to get samples in these instances.

TABLE II.—LACHIWALA SOILS.

		3. Conversion Felling.						4. Strips.						Fired Area.
		25th July.		20th September.		14th January.		25th July.		20th September.		14th January.		September.
		3″—6″	15″—18″	3″—6″	15″—18″	3″—6″	15″—18″	3″—6″	15″—18″	3″—6″	15″—18″	3″—6″	15″—18″	3″—6″
Gas ...	Carbon dioxide %	11·2	14·4	...	15·8	...	...	...	10·1	...	...	0·5	1·8	4·7
	Oxygen %	6·9	1·3	...	0·8	...	...	...	3·3	...	...	19·6	17·6	15·9
Calculated on dry soil.	Moisture %	24·2	25·8	28·2	26·4	26·5	26·8	24·9	25·2	24·6	24·7	24·0	24·3	20·7
	Organic matter %	6·4	5·6	5·5	5·5	5·5	6·6	5·1	5·3	5·6	7·0	5·1	4·6	5·1
Value of water-free air-space in c.c. per 100 c.c. of soil in situ.		1·7	17·1	3·8	10·5	15·4	13·4	5·2	6·9	11·3	3·5	11·4	17·3	26·9

N.B.—The blank spaces where no entries are made as to the composition of soil-gases indicate that it was difficult to get samples in these instances.

Table III.—Mechanical Analysis.

	Chandbagh Soils.		Lachiwala Soils.				
	Cleared Plot.	Under leaf cover.	1. Coppice.	2. Grass.	3. Conversion felling.	4. Strips.	5. Fired area
	3″—6″	3″—6″	3″—6″	3″—6″	3″—6″	3″—6″	3″—6″
Clay—24 hours' sediment ...	16·7	19·5	18·1	15·6	17·6	15·9	14·6
Fine Silt, 30 minutes	20·0	22·8	22·7	26·4	20·7	14·5	20·8
Silt - 75 seconds	32·0	28·0	51·3	47·4	50·4	50·1	23·4
Sand	31·3	29·7	7·9	10·6	11·3	19·5	41·2

N.B.—The above figures are calculated on a water free basis. The sub soils at 15″—18″ had practically the same composition as the surface soils.

THE FROST OF 1925 IN THE *SAL* FORESTS OF THE UNITED PROVINCES.

After some years of mild winters with little or no frost a severe frost, the severest since the great frost of 1905, occurred in the 3rd week of January 1925. This frost did much damage to the "*arhar*" crop at this time in full flower, and as recorded in the newspapers was felt as far as Poona. The effect of this frost on *sal* under various systems of management is of considerable silvicultural interest and teaches several important lessons in forest management which should not be lost sight of in the future.

In the Gorakhpur and Tikri forests, where the system of management is simple coppice and where frost damage is a factor which hitherto has been considered of little importance in forest management, the entire foliage of one or two year old *sal* coppice in Tikri has been killed off. In Ramgarh coupe coppice one year old and 4—8 feet high has with few exceptions been killed to the ground. In coupe IX, 5—10 feet in height, *sal* has been killed to within 2 feet of the ground, and the planted teak up to 3 feet in height have been frost bitten to ground level. In older crops the damage is especially noticeable in low lying places with much grass Here the *sal* has been killed down to about half its height. Appreciable protection has been given by miscellaneous species mixed with the *sal*. Crops older than 8 years have escaped altogether. It should be noted that where 1st and 2nd cleanings had not yet taken place the frost damage was much less.

The lessons to be learned under this system of management are to delay cleanings in young crops till the winter is over and it is for consideration whether the technique should not be amended by leaving a shelter of miscellaneous species in the main fellings which can always be removed in the subsequent cleanings when no longer required. It is not thought that permanent damage has been done beyond the loss of two seasons' growth but it is quite evident that frost must be considered in these divisions and provided for in the management.

In the forests of Pilibhit and South Kheri under the system of coppice-with-standards no damage has been done except in *chandars* where there are no standards. In the experimental area

cearfelled in the Gola range, frost damage has occurred, although in the original shelterwood experimental area there is no damage. In the South Kheri *chandars* where *sal* had grown up splendidly during the mild winters of the last 4 years very considerable damage has been done, but still there is a net gain in these areas and with the luck of 2 or 3 mild winters much of these areas may be expected to grow up into forest.

Damage has been most severe in the larger open *chandars* in Kishanpur and Hirapur ranges where *sal* shoots which were growing up splendidly in rank grass were damaged to heights of 8 to 14 feet to which size these crops had reached. The smaller saplings have been killed back to ground level and the larger ones will lose about 3 to 6 feet of the tops.

In the *chandars* in Mailani range the damage has been less severe, shoots of about 5 to 6 feet being killed back and larger ones up to 10 to 12 feet escaping with the scorching of their leaves or only portions of the leading shoots. *Sal* shoots on the edges of the *chandars* protected by forest growth alongside have generally not suffered so much as *sal* shoots out in the middle of the *chandars*.

In Hirapur range frost got into some of the low-lying compartments along the Ul Naddi where the forest was open but the damage was not serious here.

Under the shelterwood system of Dehra Dun and Ramnagar damage has only occurred where the canopy either was absent or far too light.

In conclusion it is quite evident that a shelterwood is absolutely necessary over by far the greater portion of the province, that even in Gorakhpur frost must be recognised as a danger that occurs periodically and that must not be neglected and that miscellaneous species can be used to protect young *sal* from frost. The damage done in the subsequent removal of this overwood can be controlled by lopping and if necessary careful departmental felling and this matter is already being taken up in one division. I have to thank the Divisional Officers who have kindly supplied me with the information contained in this note.

C. G. TREVOR, I.F.S.

BAMBOOS IN THE CHITTAGONG HILL TRACTS DIVISION BENGAL.

The following species of bamboos are extracted from the Chittagong Hill Tracts Division for use in Chittagong:—

1. *Bambusa Tulda*, locally known as *metenga* grows gregariously in all the Reserves. The height of the culm in 30′—80′ and diameter 2″ to 4″. It is used for house-posts, rafters and basket-making. It is abundant in the Kassalong and Sitapahar Reserves, but on account of its large size extraction is limited.

2. *Oxytenanthera auriculata*, locally known as *kaliseri*. It is a large bamboo and grows plentifully in the lower part of the Kassalong Reserve. The culm is dark green streaked with yellow 30′ to 60′ high and is used for making the walling of houses, floors and basket-work.

3. *Dendrocalamus longispathus* locally known as *orah*. A large and often gregarious bamboo growing in open clumps, culm light or dark green, 50′—70′ high and 4″—6″ diameter. It has a large cavity between the nodes and is locally used by hill people as receptacles for carrying water and milk. It is also used for house-posts, baskets and mat-making.

4. *Melocalamus compactiflorus* locally known as *lota*. It is a climbing bamboo and abundant in the upper part of the Kassalong and Ringkhoong Reserves where it is doing as much damage to the timber trees as creepers. It is locally used for making small baskets by the *Chakmas*.

5. *Teinostachyum Dullooa* locally known as *dolu*. It is a medium-sized to large bamboo growing in open clumps. The culms are dark green and 30′—50′ high and 2″—5″ diameter

The hollow part of the cavity between the nodes is big and long and used by bamboo-cutters and hill people for carrying water. It is used for wall and floor-making, for basket-work and rafting cotton, sun grass, timber and vegetables, etc., in small and shallow streams by the hill people. Ten to twelve lacs of *dolu* bamboos are used annually for sun grass rafting from the Kassalong Valley to Chittagong.

6. *Melocanna bambusoides* known here as *muli*, *paia* and *awarja* (*Chakma*). A medium sized or large bamboo growing not in clumps but gregariously in separate culms arising from branches and spreading rhizomes. Culm green when young, and yellow when old; 30′—70′ high, 1″ to 3″ diameter; used for walling, floor making, *tharja* roofing, fencing aud basket works and also used for rafting timber in shallow streams.

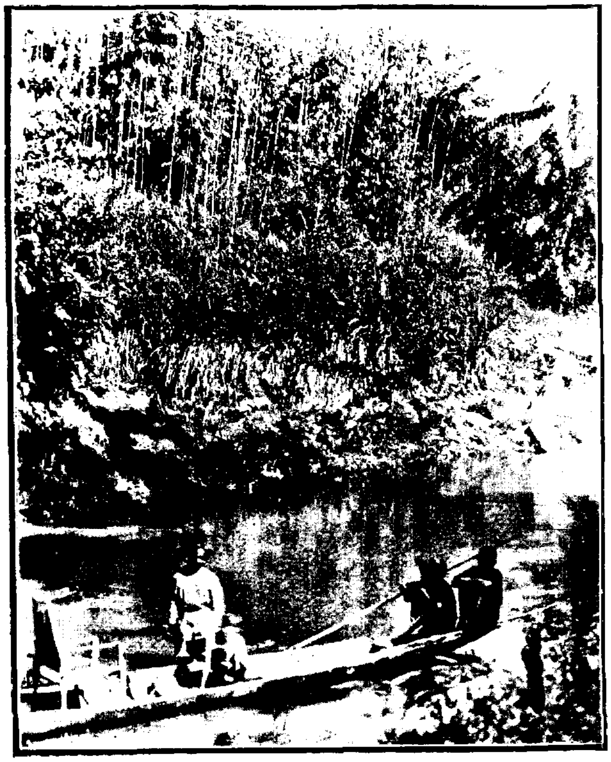
These are the principal species of bamboos now in use in the Chittagong Hill Tracts, besides them the following species are also in use :—

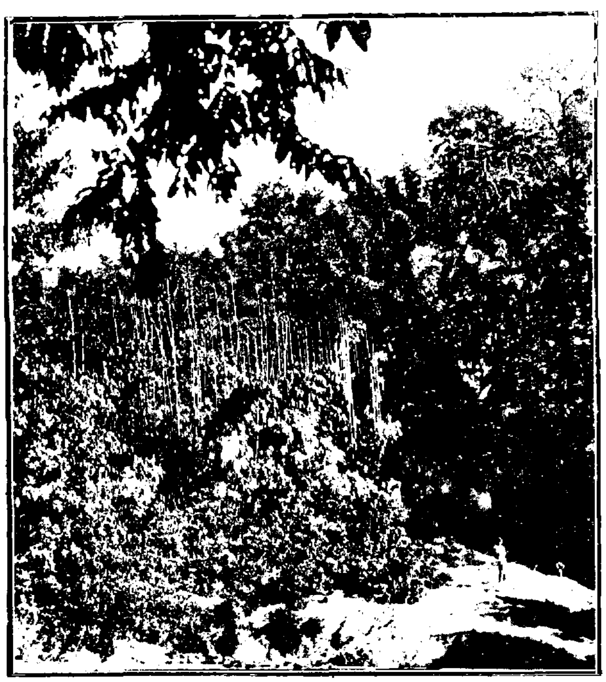
(1) *Teinostachyum Griffithii*, locally known "*Bazali*".

(2) *Bambusa vulgaris* locally known "*barialla*".

System of working.—The Chittagong Hill Tracts is by far the biggest bamboo growing area in Bengal and the inhabitants depend entirely on the bamboos for making their houses. At present the bamboos in the Reserve forests are worked under a rotation of 3 years. The biggest bamboo forest in the Kassalong Reserve has been leased to India Paper Pulp & Co. from 1st January 1920. They have been allowed to cut and remove all the species of bamboos except *dalu* which has been kept for rafting sun grass. All bamboos from the other Reserves as well as from the Unclassed State Forests have been cut and removed by the public on royalty system. The Working plan has been introduced in this Division from 1923 and the working of the bamboos is now done according to the plan. The royalty is realised at a fixed rate sanctioned by the Conservator of Forests, Bengal.

Scarcity of bamboos.—The price of bamboos in the Chittagong Hill Tracts has gone up recently. The price of bamboos was in





Photos. by M. C. Chaudhuri.

Fig. 1. One year old Bamboo in a jhumed area in Agaratum (*Eupatorium*) in Maini Head Water Reserve, 15th November 1923.

Fig. 2. Two year old Bamboo in a jhumed area in Agaratum in Maini Head Water Reserve, 14th November 1924.

Fig. 3. One year old Bamboo in a jhumed area in Agaratum in Maini Head Water Reserve, 15th November 1923.

Fig. 4. Two year old Bamboo in a jhumed area in Agaratum in Maini Head Water Reserve, 14th November 1924.

1919-20 from Rs. 16 to Rs. 40 a thousand, but in the current year the price is as follows:—

Mainimukh	Muli	Rs. 80	a thousand.
	Dalu	Rs. 120 to 150	do

The price of bamboos at Mainimukh is high, because the bamboos are required for rafting sun grass. The price of *muli* bamboos at Chandraghona is Rs. 40 to Rs. 60 a thousand at present.

Statement showing the number of bamboos extracted from the Chittagong Hill Tracts Division and the revenue received.

Year.	Number of bamboos extracted.	Revenue realised in C. H. Ts. Dn.	Total revenue on bamboos in Bengal.
	Rs.	Rs.	Rs
1919-20	78,73,205	36,184	73,105
1920-21	65,07,877	31,944	81,243
1921-22	100,96,729	42,004	98,444
1922-23	100,32,322	57,073	1,11,349
1923-24	101,66,413	54,947	91,953

The bamboo statement shows that nearly 50 p. c. of the total revenue on bamboos is actually realised from the Chittagong Hill Tracts Division.

The bamboos in the Hill Tracts have been destroyed by jhuming. We have reserved about 135 sq. miles of jhumed land in the head waters of three streams as reserved forests and I found that bamboos are coming up among the Eupatorium plentifully. I have seen the bamboos in 1923 and 1924 in the same jhumed area and found that they are doing well and there is every chance that the jhumed area if protected can easily be filled up with bamboos within 2 or 3 years. By burning the rhizome is not killed and can give out shoots as soon an burning in stopped.

Seedlings of bamboos:—It was noticed in this part of the forest that *orah* and *metenga* bamboos flowered sporadically everywhere. No regular flowering is noticed all over the area. During

my stay of over 5 years as Divisional Forest Officer I have noticed every year that the *orah* and *metenga* bamboos produced flowers in some part or other.

Reproducton. – The natural reproduction of *orah* and *metenga* and *dalu* is very favourable in the Reserved Forest of the Chittagong Hill Tracts.

Enemies.—Elephants cause heavy damage to bamboos all over the Kassalong Reserve by uprooting the clumps especially on ridges and destroying all the young shoots by twisting and crushing. Elephants are plentiful both in Kassalong and Ringkhoong Ranges and in both places damage is heavy. It is desireable to run a regular Kheddah operation to stop this damage.

The following statement will show the revenue realised and numbers of bamboo extracted during last 5 years from the Sitapahar Reserve (known as Kaptai Forests), the area of which is 21 square miles and the actual bamboo area will be about 15 square miles and is worked under a rotation of 3 years, *i.e.*, 5 square miles worked a year :—

Year.	Number of bamboos extracted.	Revenue realised.
	Rs.	Rs.
1919-20	17,75,470	8,072
1920-21	19,74,061	7,998
1921-22	20,66,685	9,681
1922-23	26,46,260	11,987
1923-24	29,84,111	15,005

In 1923-24 we obtained Rs. 15,005 for the total area of 15 square miles, *i.e.*, Rs. 1,000 per square mile which gives an annual income of Rs. 1-8-0 per acre for bamboos. This Reserve is the only easily accessible forest and so has been worked out completely.

Special quality of bamboos.—The bamboos in other parts of the country are attacked by borers (called *Ghoon*)* but in the Hill

* The common bostrychid borers of bamboo, *Dinoderus brevis*, *D. minutus* and *D. occellaris* appear to be absent from the Chittagong Hills.—*Hon. Ed.*

Tracts I have not noticed the bamboos attached by borers, although they are used for walling, roofing and keiling of houses all over the Hill Tracts and Chittagong Districts.

M. C. CHAUDHURI,
Divisional Forest Officer,
Chittagong Hill Tracts.

12th March, 1925.

THE APOCALYPSE.

A JUNGLE OF BEAUTY.

It has probably never occurred to those bright people who concoct Working Plans, what very drab reading their jungle impressions make as recorded in Compartment Histories. We can readily excuse, if we do not condone, those technical fantasies and quaint conceits peculiar to Chapter Six, Part One of their Magnum Opus. Indeed from that happy hunting ground of our senior wanglers, many expect, and even welcome, vagaries. There is a world of comfort in the thought, as one plunges perspiringly through a jungle of absurd density (perforce playing a sort of "Oranges and Lemons" with the local creepers) that the 600 odd acres awaiting the clasp of one's calliper are really *tiny* little fellows (considering their reduced quality, you know) forming an area about the size of a brace of Sample Plots. We must all, too, feel a warm sympathy for the jungle itself, which not only forms a number of Circles but is expected at the same time to become a right-angled triangle with a baser. That it will abandon this Pythagorean project if we neglect its smallwood, should, in these days of organised minorities, occasion no surprise. And the matter, it seems, is merely one of a growing stock of grievances.

But, as I've said, our Compartment Histories are pitiful starved things. They all read alike—colourless, uniform socialised. Take the following :—

"On the eastern slopes (below the Raddi Rau) the soil is more loamy and carries an ample crop of miscellaneous species at least 50 years old and requiring thinning badly ; well-grown young Sain are also found in different parts but are absent on

stony ground. Grassy *tappars* are scattered everywhere. Damage from *Gauj* is decreasing owing to systematic cutting in the past. . . ."

—and so on, *ad nauseam forestatem.*

Now, that this is all the jungle presents even to our unseeing gaze, I do not for a moment believe. We are victims, surely, of colossal self-deception, of an immense fraud. For there are those in my office to whom the full beauties of an Indian Jungle are gloriously manifest. To realise the immensity of our loss, and the wickedness of an official policy, or tradition, suppressing the true facts of Nature, I propose to submit the sublime original from which the above vapid emendation sprung. Compare sickly child and radiant mother! (Family forward please.) The archetype is as follows :—

"In the cistern slops (blow the raddi rau) the soil is more loomy and carries an apple crop of miscellaneous spices at least 5,000 years old and requiring thigging ; blady well-gug-grown young Sinner also found ; indifferent pats butter absent on sconey ground. Glassy *stoppers* are scattered everywhere. Damage from *Gorjes* decreasing owing to systematic catting in the past. . . ."

Comment on a masterpiece of this nature is almost an impertinence. Here, surely, is an area to show with pride to one's touring Conservator and to the experts in saxaphone symbology for Sal ! There is a freshness, almost a baza. . ...(I never can spell it—thank you) a *bizarre* touch in this Compartment description which sets it apart from all others. It is quite unique in its, er, uniqueness. Indeed several passages in it are well worthy of Milton (I refer, of course, to the poet not to the disinfectant).

A note of Eastern mystery pervades the writer's theme. Passing over the "slops" (a habit to be recommended) we pause at "loomy" and recall the Jabberwock Epic which puzzled Alice so. Whatever this obscure terrestrial quality, keen silviculturists will note the resulting apple crop, complete with spices, and a dynastic rotation which only their presence can excuse. These apples must taste lovely and any "thigging" is to

be deprecated. Somehow it sounds drastic ("Thugging?" Ed.) Neither they nor the butter (inconsiderately absent on "sconey" ground) have ever come my way in the jungle. Still, this would account for so many butterflies . . . Next inspection I really must take an empty barrel with me . . . . . . or at least an empty stomach and an unbiassed mind.

But there is more immediate food for thought in the preceding passage. The, er, " . . . . . . well-grown young Sinner," referred to with emphasis and some emotion, fills me with mystification and a mild alarm. To repudiate the innuendo is my first duty; to establish an alibi the second. This Division is so well served by roads that to enter a Compartment is an obsolete and quite unnecessary proceeding. Besides, this cannot, I am sure, refer to a Forest Officer, however well-grown. An *ordinary* sinner, perhaps: but one with a large "S" never. No Forest Officer ever has any capital.

In the "glassy stoppers" we strike a Western note (though a cork is now-a-days more favoured) and their regrettable abundance argues a widespread movement of char-a-banc trippers imbued with O. K. (Omar Khayyam) principles. At least no other explanation is suitable.

On the writer's style and choice of words I speak with diffidence. The telegraphic brevity of the whole is much reminiscent of Carlyle, the robust, almost strong language of—well, *not* of Carlyle at any rate. That the passage opens on a note of impatience, and even irritation, must be conceded; and certain expressions, while admittedly familiar to me (and possibly to others) in a different connection, I have not hitherto encountered in an Epic work of this nature. However, it is not ours to criticise. In the words of the proverb, "Those who live amongst glassy stoppers should not throw stones," and we would not wish even to drop a brick. That forcefulness which a great theme demands must be accorded full scope. One cannot, however staunch to the Eighteenth Amendment, license the Gods drinking nectar on Olympus.

The actual author I wish I could acclaim. But it seems he represents a *type* rather than an individual, that he casts his wonderful spell in many a prosaic office. For the rest, I may

submit one more touch, enlightening yet mysterious, from the masterhand. Such well-worn, nigh meaningless, words as "Both areas should be included in the First Periodic Block"—a phrase familiar to us even in the Nursery—obscure a world of poetry or rather of music. In their pristine beauty we read "Bach arias should be included in the Forest Pocket Book."

Here in a sentence we U. P. forest officers learn the catholic range of our little green friend. Its months of faithful service as a prop to the leg of my piano appear prophetic. For truly, in its elastic band and wide range of notes we now perceive a fresh significance, and glimpse for a moment the harmony of things forestal.

φ ο ρ δι.

Important note.—I have just discovered that the whole thing is, after all, a mistake due to someone's carelessness. This disclosure is necessary if only to anticipate promptly the rush of experts to my Division, which would have caused me endless inconvenience, besides damaging the jungle. A slight amendment of the title may be suggested. For "Apocalypse" read "A pukka lapse," followed by "A bungle of duty".

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REVIEWS.

RIVER TRAINING IN BURMA.

REGULATION OF RIVERS WITHOUT EMBANKMENTS, by F. A. LEETE, C.I.E., I.F.S., Chief Conservator of Forests, Burma, assisted by G. C. CHEYNE, I.F.S., Deputy Conservator of Forests, Myitmaka Division, London, Crosby Lockwood and Son, 1924, pp. 122, 10 Maps, 9 diagrams, 36 plates. Price 30 shillings.

This handsome volume published by Crosby Lockwood & Son will take its place with the classics of Indian Forestry from the hands of Brandis, Gamble, Troup and others. It describes clearly how a number of very troublesome streams in Lower Burma were made to behave themselves. For many years these streams on issuing from the Pegu Yoma Range, had always during the rains divided into many small channels, overflowed their banks, and carried the Government teak logs far and wide across country. The difficulty was increased by the flood water from the Irrawaddy and the Rangoon rivers which dammed up the smaller rivers and increased the accumulation of water on the plains. In a few words, what Mr. Leete and Mr. Cheyne did was to devise several most ingenious methods whereby these streams were induced to cut good clear beds for themselves, so that without great expense they brought out the timber to the main floating stream. The frontispiece gives a good idea of what wonderful work it was, showing the Taungnyo (brown-hill) stream flowing between eleven-foot banks, although the channel is only 5 years old and the banks are entirely composed of the rivers own deposits. In his Preface Mr. Leete says, "Control without embankments cannot be effective with all kinds of rivers. It is only applicable to streams which start as hill torrents heavily charged with sandy silt. Such streams are everywhere subject to variations in flood levels and in high floods overtopping of the banks is common. In tropical countries, with the greater part of the rainfall confined to half or less than half of the year, hill streams are torrential in character, and bank overflow is very

frequent indeed. After every storm the streams come down in spate, and it is a common occurrence for the flood waters, after leaving the hills and reaching the lowerlying parts of the plain, to spread far and wide over the country side."

"Although the Myitmaka Training Works were started by the Forest Department of the Government of Burma for the purpose of floating out teak logs, the operations have proved to be so remarkably successful in the protection of cultivation from flooding, and in the reclamation of lowlying and swampy land, that they would certainly be continued even if the rivers ceased to be of importance for logging purposes."

"The one outstanding personality in the operations is that of Mr. G. C. Cheyne, I.F.S. He has been intimately connected with them from the start, first as timber Assistant and later as Divisional Officer, Myitmaka Extraction Division. It it no exaggeration to state that the splendid results obtained have been due entirely to Mr. Cheyne's untiring efforts. The work has been strenuous, conditions arduous and the responsibility heavy. Mr. Cheyne has proved himself times without number to be the right man in the right place. The Government of Burma does indeed owe to him a great debt, which will, I trust, find suitable acknowledgment in due course."

Mr. Leete's attention was drawn to the problem in 1913 when he found that "no matter how many logs were put into the streams in the hills, the number of logs which reached Rangoon annually diminished steadily, and it looked indeed as though the operations were in danger of coming to a standstill." Attempts to control these rivers began in 1852 soon after the British came to Lower Burma and have continued at intervals ever since. The crux of the problem is the disposal of the sandy silt brought down from the hills in immense volume and the two great troubles to be overcome were the obstructions in the beds and the unevenness of the banks. By clearing the beds of all obstruction and by cutting a small leading channel across the shallows, the rivers were induced to keep on the line of their old beds when they came down in spate, and by dressing the bank level, the overflow was kept uniform and an even layer of silt was deposited on both sides, thereby raising both banks.

Streams which flow through densely wooded hills are peculiarly liable to have their channels blocked by obstructions, snags, immense heavy old roots, masses of dead bamboos and so on, and these were removed by blasting, cutting and burning. As for the more difficult part of the work, it is interesting to note that as long ago as 1877 the Deputy Commissioner of Tharrawaddy had an idea of the proper thing to do—and that is, to build small fences on both sides so that the silt will be deposited. The success of the work lies in two directions The teak logs come out as they are meant to do, they are rafted and sold in Rangoon and not lost in the mud. The other great advantage of the work is that the area under cultivation is steadily increasing. The streams drain an area of 560 square miles in the hills, which rise to about 2,500 feet, and are covered with teak and bamboo forests Since 1915 the silt brought down has rendered cultivable about 10,000 acres of swamp-land, and reclamation is proceeding steadily at the rate of two square miles per annum.

The Burmese word *Laha* is much in evidence. The accent is on the last syllable, and the word means a flat which is inundated annually, and is dry during the hot weather.

It is worthy of note that in 1909 the Conservator said he would not recommend the waste of Government money on training works until the protection of the catchment area had been fully assured by the prohibition of shifting cultivations. This was a very much mistaken view. The Karens did not cause much erosion, because their clearings were very quickly recovered by jungle. Jams of logs caused by the obstruction were of frequent occurrence and a good account of how a jam of 3,000 teak logs was dealt with by Mr. Cheyne is given on page 35. His principle was, as always, to make the river do its own works. A small crooked channel was made through the jam with great difficulty. When the water began to run down this, progress had begun, and gradually the stream increased and scoured out a channel. The logs as they were pulled out were put along the stream in the now famous "herring-bone" pattern. This method of disposal has been used a great deal by Mr. Cheyne with the object of directing the water towards the middle of the channel and encouraging the removal of

deposits. Some idea of the conditions in this tract may be obtained from the following extract:—

"A study of currents in the Myitmaka is of the greatest importance for officers in control of logs after they enter the Myitmaka from the hill streams. Lack of attention to this detail may result in excessive expenditure on booms, and this is a matter of some moment, because the number of logs used for the purpose runs into several hundreds, even if the greatest care is taken. On the other hand, if booms are not placed where required, large numbers of logs may go astray, causing extra expense and trouble in recovery. In such a vast network of swamps and jungle the possibility of logs being lost sight of altogether is by no means inconsiderable. It is to be remembered that boats are a necessity for the local population for the greater part of the year."

Several fine photographs show how ancient teak logs which had been burried for any period up to 60 years were recovered during these operations, and the value of these more than paid for the work done. The volume is illustrated with many maps, section drawings and photographs from which full details of this very fine work can be learned. The Government of Burma have drawn attention to the great economic value of this method of control.

They say," This method, which was thought out by Mr. Leete and put into practice by Mr. Cheyne has been eminently successful and has added not inconsiderably to the economic welfare of Burma."

THE EFFECT OF GRASS ON THE GROWTH OF TREES.

THE EFFECT OF GRASS ON TREES, by A. HOWARD, C.I.E., M.A., Pro. Roy. Soc., B. Vol., 97, pages 284-320, Figs. 4, Plates 14—18. 1924.

This reprint from the Proceedings of the Royal Society will be read with interest by foresters. The experiments were made at Pusa and therefore the results apply primarily to the Gangetic alluvium. After the middle of the monsoon the pore spaces near

the surface of the soil become water-logged, percolation stops, aeration is interfered with, the absorbing roots in the lower layers of the soil die and only those in the upper few inches supply the tree with food material. During July and August there is a rise in the subsoil water-level and a rapid fall to normal in October.

To discover the effect of grass on trees, plots were laid out on which were eight species of fruit trees with and without grass, with grass but aerated by trenches, etc. The grass was *Cynodon dactylon.*

An examination showed generally that the trees possessed each two distinct root-systems, one superficial in the upper 18 inches of the soil, the other deep-seated and just above the water-table. Under clean cultivation there is only occasional activity of the absorbing roots in the superficial layer during the resting period of December and January. As the surface soil dries the absorbing rootlets in the superficial layer die and the deep-seated roots become active From about the middle of March till the break of the rains only the deep-seated roots are absorbing though a fall of rain will cause temporary activity of the surface-layer. This deep-seated activity explains why so many Indian trees are able to start into active life in the dry hot weather and also why the leaves are so often pale in colour for there is a lack of nitrogenous material in these deeper soil-layers. During this hot weather period, grass is dormant and there is no competition. When the rains break both the superficial and the deep-seated roots are in full activity for a time. Late in July when the rise in the water table occurs the deep-seated actively absorbing roots are killed and from August to October only the surface roots are active. In October there is some renewal of the deep-seated root activity.

As grass growth and tree growth coincide except for the hot weather period, it will be seen that during the hot weather, when only the deep-seated roots of the trees are active, grass is not competing ; during the early rains grass will affect the surface tree roots but the deep-seated roots will still be active ; during August to October the grass will severely affect the trees as it will compete with the superficial roots and the deep-seated roots are rendered

inactive by the rise in the water table. For the remainder of the year there will be no competition.

A careful examination of the root-system of young trees showed that under grass a very weak superficial root-system was produced though the deeper root-system was well developed. As a result grass competed successfully ; it killed some species of fruit trees and greatly retarded others. The guava which forms superficial roots in spite of the grass was least affected.

The harmful effect of the grass on established trees is less but is still great. The order of susceptibility is much the same, that is those trees most affected in youth are most affected later. The fruit trees under grass (except the guava) form few active rootlets in the superficial root-system during July with the result that when the deep-seated root-system ceases to function in August the trees have nothing to fall back on.

The plots where aeration trenches were dug showed that aeration certainly mitigated the evil effects of the grass but did not eliminate it and the effect of the trenches varied with the species.

A careful examination shows that the presence of grass increases the amount of carbon dioxide in the soil air throughout the year and particularly during the rains, it reduces very considerably the amount of nitric nitrogen in the upper 18″ of soil where the superficial root-system should be actively absorbing and it reduces aeration. These three factors account for the harmful effects of grass on the fruit trees, and Mr. Howard conclusively explodes the soil toxin theory.

Certain observations are then given on forest trees which have been under grass for at least 18 years to ascertain "the nature of the weapons by which these trees are not only able to thrive under grass, but also to vanquish it, if allowed free competition." It was found that all the trees possessed the two root systems but whereas the grass seriously affected the activity of the superficial roots of the fruit trees (except the guava) these forest trees had apparently perfectly normal superficial root-systems able to compete for nitrogen with the grass during the rains. The final conclusion is "the character which distinguishes forest trees from fruit trees appears therefore to be the power possessed by the surface roots of the former to resist the harmful

effects of an atmosphere rich in carbon dioxide. That the roots of different species vary greatly in this respect is well known. So great is this resistance in the case of forest trees that the roots are able to reach the surface in the presence of a grass carpet in active growth and to obtain oxygen as well as a portion of the combined nitrogen available."

Mr. Howard's observations and arguments as to how exactly grass causes harm are convincing, and his diagrams drive the points home. In one matter only we are not in entire agreement with him namely when he instances the different behaviour of forest trees. His facts and observations cannot be disputed but there seems to be rather more to it. In early youth forest trees vary much in their power of competing with grass but many of them—the vast majority of them—are quite unable to compete if grass and trees are sown together on bare land. If fruit trees were sown as profusely and repeatedly as forest trees on grassy blanks we believe it possible that as many—or as few—would survive.

Mr. Howard's reasons seem to show undoubtedly why the young fruit tree cannot compete with grass, but his conclusion applies, it seems, with almost equal force to the young forest tree. That the young forest tree—even the *Sissoo*—can be easily killed out by grass we have proved repeatedly by experiment.

The different behaviour of the established tree we are inclined to believe is more a question of species and age than any fundamental difference between fruit trees and forest trees, though we cannot here back our statement by experiment. Mr. Howard bases his conclusions on observations on fully grown fruit trees grassed over in 1921 and compares them with forest trees known to have been under grass for 18 years. It would be interesting to know the ages of the fully grown fruit trees when they were first put under grass. If young forest plants were put under grass many would be affected just as the fruit trees were affected. Is it not possible that with both fruit trees and forest trees the harm done if grass were introduced would depend on age and vigour that at first introduction there might be with both forest trees and fruit trees few active rootlets in the superficial layers but that after some years the

tree might adapt itself sufficiently to develop a good superficial root-system. To the forester grass is a deadly enemy though there certainly are trees which can compete with it.

INDIAN BIRDS.

THE FAUNA OF BRITISH INDIA. BIRDS,—VOLUME II (second edition). By E. C. STUART BAKER, O.B.E., F.Z.S. &c.; Taylor and Francis, London, 1914, Price 30*s*.

The volume appeared nearly a year ago so this notice is somewhat belated and serious students of the subject have doubtless already read the reviews which have appeared in the various journals devoted to Ornithology and Natural History generally. In any case I only intend to deal with the work from the point of view of the ordinary forester who, like myself, is a more or less unscientific observer and field naturalist.

To begin with I would urge all foresters, who are not too near the end of their service and take an interest in the birds they see, to possess themselves of a copy of this work. It is one that is not likely to be superseded during the service of even the latest joined recruit. Like a good gun, rifle or fishing-rod it will see one through one's service.

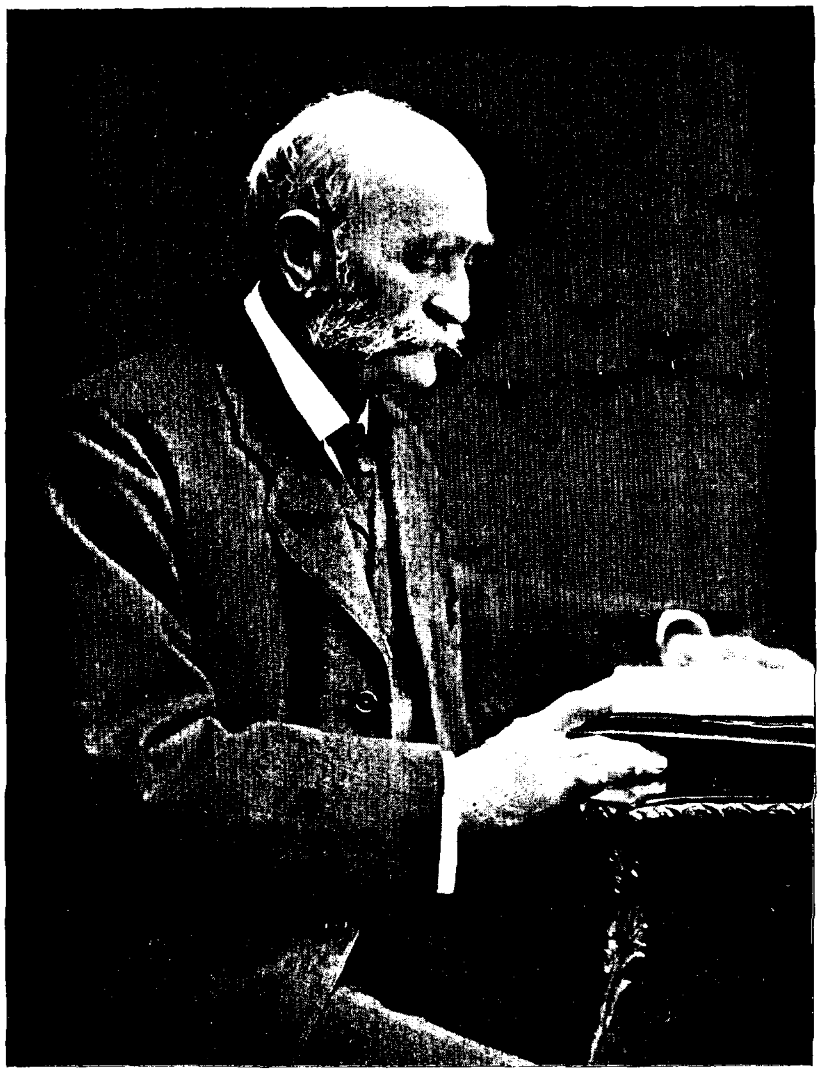
The Author's preface to this volume contains two items of good news, firstly that the rate of production has been speeded up so that Vol. V, which concludes the description of species, should appear (if my calculations are correct) not later than October 1928 instead of August 1930 as originally promised; secondly that a sixth volume has been sanctioned to include, besides addenda and corrigenda, a full synonymy of all first references.

This promise of a synonymy may leave some field-naturalists cold and I confess that it would have held little interest for me a year ago, in fact I was rather pleased to see no references except to Blanford and Oates, at the head of each species when the first volume appeared. Since then, in Tibet, I tried to wrestle with Dresser's Palearctic Birds, Blanford and Oates Fauna and some recent tri-nomial lists all differing in nomenclature,

so that I more than once found that what appeared to be three birds in the lists was only one in the flesh. Hence my respect for synonymy.

There is little to remark about this volume other than what I wrote about Volume I. It has been pointed out to me that many of the birds occurring in the Sunderbans have not had that locality given under their distribution. I have asked the naturalist who pointed this out if he would be good enough to publish a list of Sunderbans birds in the Bombay Natural History Society's Journal, as it does not appear to have been done and he is in the best position to do so.

E. O. S.



SIR WILLIAM SCHLICH, K.C.I.E., F.R.S., D.Sc.
1866—1889
Honorary Editor of the Indian Forester, 1875—1878.

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INDIAN FORESTER

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THE INDIAN FORESTER, 1875–1925.

As pointed out by Mr. Gamble in a previous number, the Forest Conference, held at Allahabad in the beginning of 1874, decided unanimously to establish a forest magazine and asked me to carry the resolution into effect. Accordingly, I issued the first number on the first of July 1875, under the title :—

"THE INDIAN FORESTER."

It was a somewhat risky experiment, because the new journal's existence depended on the support which it might receive from the members of the Forest department. It was an entirely private undertaking without any support by the Government. However, a sufficient number of subscribers were enrolled to justify my going on. An adequate number of articles were received to fill each number. I retained the honorary editorship until 1879, when, after twelve years of strenuous work, I took the first and only furlough during my service in India. I had made all expenses and, over and above, I handed to Mr. Gamble, who kindly took over the honorary editorship, the sum of Rs. 400. Mr. Gamble held the editorship, in two instalments, for twelve years, and in 1899 it was permanently made over to the Dehra Dun School of Forestry. The *Indian Forester* had its good days and its evil days, but it has held on. And now, at the age of 85 years, I have the great pleasure of being still here to assist in celebrating the 50th anniversary of its birth. The first half of the 50 years falls into the 19th and the second half into the 20th century.

In his "Forestry in British India," Ribbentrop says that the 24 volumes of the *Indian Forester* published up to 1899 contain much of value and interest. Stebbing, in his "Forests of India," Volume II, states that the conception of issuing a monthly magazine was a brilliant one and he continues :—

"......During twenty-four years (1875—1899) the magazine had its ups and downs. It was no easy matter to keep a journal of this kind going month after month......In spite of all vicissitudes, the *Indian Forester* remains a record, though incomplete, of the achievements and disappointments experienced by the Department... . It is a mine of information and there is a great deal to be learnt from its pages. Had the century given birth to no other literary achievement than the *Indian Forester,* it would not have been barren of literary effort."

I may add that during the period of 1900—1925, with its further and rapid development, the *Indian Forester* has continued its usefulness not only by recording passing events but also by publishing an increasing number of important papers on subjects under discussion from time to time.

Under these circumstances, it seems to me that some notes on the progress in forest administration and management during the last 50 years would not be out of place. The matter is, however, one of considerable extent, and I propose to restrict myself on the present occasion to drawing attention to some important events, which occurred during the latter half of the 19th century, hoping that some other pen will deal with the highly interesting period of 1900 to 1925.

It has been repeatedly stated that the dawn of systematic forestry on a scientific basis in India commenced when Lord Dalhousie, the Governor-General of India, took up the subject in 1855. The Burmese province of Pegu had been acquired in 1852. A Superintendent of its valuable teak forests was appointed, but progress was slow probably due to differences of opinion between him and the civil officer in charge of the province. References were made to the Government of India and Lord Dalhousie drew up and forwarded to the Pegu authorities a Memorandum, dated the 3rd August 1855, in which he laid down, for the first

time, the outline of a permanent policy for forest administration. In the meantime, he looked about for a competent man to take charge of the Pegu forests.

How Brandis came to India.

One evening, while at dinner at Government house, Lord Dalhousie complained to the lady sitting next to him that he had great difficulty in finding a competent man for the Pegu forests, when the lady replied that perhaps she might help him, and suggested her brother-in-law, Dr. Brandis. She told him that Dr. Brandis was a Lecturer in Botany at Bonn University, a man of great knowledge, and energy, who had, in connection with his botanical work, come much into contact with forest officers and acquired a good insight into their system of managing forests Lord Dalhousie took up the idea, made inquiries about Brandis' qualifications, and, these being satisfactory, wrote to him to the effect that, if he would come to India, the Government would appoint him Superintendent of the Pegu teak forests. It will be interesting to readers to know that the lady in question was the wife of General Havelock, the hero of the first relief of Lucknow. Brandis accepted the offer and landed in Calcutta early in 1856. He had an interview with Lord Dalhousie and explained to him his ideas on forest management. Before leaving, Lord Dalhousie said:" Dr. Brandis if you are carrying out these principles, you will confer a great benefit upon the country to which you are going."

On arrival at Rangoon, Brandis was informed that the vessel which brought his botanical library to India had gone down in the Rangoon River. He looked upon this loss as being almost a sign from Heaven that he should put botany aside and devote himself to forestry; however, he never deserted his old love. The details of Brandis' activity in Burma are so well known that I can restrict my remarks to a few sentences. He made himself acquainted with the actual conditions of the forests by incessant travelling and, on the basis of the information thus obtained, he proceeded to estimate their future yield capacity on the principle that the maximum utilisation must depened on the increment,

if a sustained yield is to be safeguarded. In other words, the annual yield must not exceed the number of trees over a certain girth (6 feet in this case) divided by the number of years required to replace the present stock of trees over 6 feet girth, measured at 6 feet from the ground. He also provided for an adequate protection of the forest and the economic conduct of timber extraction. All these wise measures put a wholesome reduction on the lawless destruction of the forests by the timber traders, who violently attacked Brandis, causing a long struggle which ended in a compromise. As an experiment, parts of the forests (the Ataran forests) were thrown open to the traders with the result that they were worked out in a few years, and practically yielded no return for half a century afterwards. The other forests remained under the control of the forest department. The result of Brandis' activity in Burma was that the forests were saved, and now yield very large quantities of timber and an average annual net revenue of Rs. 17,942,000.

The soundness of Brandis' management of the Burma forests was recognised by the Government of India, which sent for him in 1862 (it is believed on Dr. Cleghorn's advice) to assist it in dealing with the management of forests in other Indian Provinces. As a result of his activity, the Government of India decided in 1864 to create a regular Forest Department and appointed Brandis its first Inspector-General. The years 1864 to 1870 were a period of great activity for Brandis in organising the department in the different provinces, and he soon saw that to secure a sustained yield of the forests, a competent staff of officers was urgently required. He went to England in 1865 and, with the approval of the Government of India and the support of the late Lord Salisbury, at that time Secretary of State for India, he organised the training of young Englishmen on the Continent. In 1865 a Forest Act was passed. It contained what Brandis could get at the time, but it soon became evident that its provisions were altogether insufficient. More particularly it did not give authority to establish permanent State forests, in which the rights of third parties had been ascertained and regulated. Already in 1868, Brandis submitted to Government

a Memorandum setting forth the deficiencies of the existing Act and proposing fresh legislation. The consideration of this proposal extended over a period of ten years and final action was not taken until 1878.

In the meantime Brandis continued his inspections in the several provinces, and drew up preliminary working plans. Unfortunately, he fell seriously ill in the beginning of 1871 and had to leave for Europe, whence he did not return until 1874. During his absence, first Colonel Pearson, afterwards Mr. Baden Powell officiated as Inspector-General of Forests.

I have thus arrived at the end of the first part of Brandis' activity in India. During the period 1856 to 1870, the foundation of a rational systematic forest management in the different parts of India was laid. It has been stated in a recently published book that "The work which was undertaken during the period 1871—1900 was the natural corollary and outcome of the lines laid down between 1857—1870." In reply to that statement I should like to say that while the statement is no doubt correct in a general way just as important work was done after 1870 as before. In support of that pronouncement, I propose to remind the reader of some of the more important items.

THE FIRST TEAK TAUNGYAS.

In the first place, I desire to draw attention to the development of the Teak "*Taungya* cultivation." The combination of the regeneration of forests with the raising of agricultural crops has been practised in Europe for a long time, probably some hundreds of years. Before going to India, I had done practical work in a district where the system had been practised since the beginning of the 19th century. Ribbentrop states in his "Forestry in British India" that, as far back as 1856, Brandis conceived the idea of pressing the shifting cultivation of the Karens in Burma into the service of arboriculture by interplanting their crops with teak. Nothing seems to have been done, however, until about ten years later, when a Burmese forester, Oo Tsan Dun, began planting teak, "in accordance with orders," into his *taungyas* cultivated with paddy and cotton. Shortly after I

joined the forest service in Burma, Mr. Leeds, the Conservator' sent me to Toungoo to examine these experimental plantings, and Mr. Graham, the Deputy Conservator of the Division, took me, in July 1867, to the Kabaung forest. There I saw two small areas of teak *taungya*, one established in 1866 and the other in 1867. This was evidently the first attempt at *taungya* teak plantations. Whether it was the result of Oo Tsan Dun's personal initiation or whether he only carried out Mr. Graham's order is doubtful. Any how, the latter officer followed up the experiment, so that by 1868 nearly 100 acres had been cultivated. The success was so satisfactory that it was decided to plant during the next five years at the rate of 360 acres a year, but by the end of 1872-73 the total area planted amounted to only 250 acres. In 1873-74, Major Seaton, the then Conservator, started similar operations in the Tharrawaddy and Prome Divisions. In 1875 the area had increased to 1,050 acres, and by the end of 1898 the successfully planted area had grown to 52,000 acres. The method spread to most parts of India, so that in 1919 the total area of *taungya* plantations, as it is now generally called, amounted to an area of 94,446 acres. The development of this most valuable method stands to the credit of the period 1870 to 1900.

Brandis returned to India in 1874 and assumed his usual activity. During the next year, 1875, three important events took place:

(1) The inauguration of the *Indian Forester.*

(2) The Simla Forest Conference.

(3) The foundation of the Dehra Dun Forest School.

Each of these had an important bearing upon the further development of Indian forest conservancy. On the first of the three events, I have offered some remarks in the early part of this article.

THE FOREST CONFERENCE AT SIMLA.

A conference had been held at Allahabad in December 1873 and January 1874, over which Mr. Baden Powell presided. The principal results of it were a severe criticism of the Forest

Law of 1865, the urgent want of an improved law and the establishment of a forest magazine. In the following year, 1875, Brandis decided to go a step further by holding another Forest Conference at Simla, the summer residence of the Government of India and of the Punjab Government. This was a very wise move. Brandis has never told me in so many words, but I had no doubt about it. He wanted the Forest Department to be better known at headquarters and by the large number of influential members of the various departments, which usually assemble at Simla at that time of the year. From the very time of the dawn of systematic forest management, Brandis, and in fact the whole department, had met with much opposition by the civil administration. With the exception of a limited number of enlightened men, the members of the Civil Service looked unfavourably upon the development of this new department. Now they were brought into contact with a staff of forest officers which was at once recognised as a body of well-informed men, many of whom came from the Universities and belonged to the same class of society as they themselves. While the older members of the Forest Department were busy with important measures, the younger members mixed freely with Simla society, played and danced with the daughters of the leading men; in fact, the whole body was welcomed by Simla society. The department gained in popularity which led to the gradual disappearance of the opposition and facilitated the introduction of salutary measures in the future.

EDUCATION AND RESEARCH.

When Brandis organised the instruction of probationers for the Indian Forest Service in 1866-67, he contemplated also providing at the proper time the necessary instruction for Indian members of the staff. This could, however, not be done until a sufficient number of qualified officers had joined the department to act as instructors. He laid his views before Government in 1869. In the meantime, various temporary measures were adopted; first by placing selected Indians with qualified officers to instruct them. With very few exceptions, the results were not satisfactory. Next, young Indians were apprenticed for one

or two years in their own province, and then sent for a year to Roorkee or some other Engineering College. Again, the results were disappointing; the men learned little of forestry but became acquainted more or less, with some branch of engineering. In 1873, when Conservator of Forests in Bengal, I proposed to extend the instruction at Roorkee by adding forestry classes, but the proposal was not adopted. At last in 1875 a beginning was made at Dehra Dun. Brandis pointed out the advantages of the locality, and under the direction of Captain Bailey, in charge of the Forest Survey Department, practical training of young Indians was commenced, and in 1878 a full course of theoretical and practical instruction in forestry was inaugurated. The school was originally intended for the instruction of the Ranger and Forester classes but in course of time a course of instruction for candidates for the Provincial service was added. Now, I understand, candidates for the Imperial, or upper service will also be trained at Dehra. Considering the great changes which have lately been introduced into Indian administration generally, it is not unlikely that all classes of foresters will in a short time be concentrated at Dehra Dun.

Although belonging to a later period, I may mention that in 1906 an Imperial Research Institute was established at Dehra Dun, and has grown to such an extent that I have no hesitation in considering the combined institution the most complete of its kind on the earth. Schools of Forestry for Rangers and Foresters have now been established in other parts of India, but I cannot go into the details of the subject in this place.

Forest Laws of India, and Formation of Reserves.

At last, in 1878, the inefficient law of 1865 was replaced by the Indian Forest Law, which enabled the formation of Reserved State Forests on rational lines including an official enquiry into the rights of third persons in the proposed State Forests, their regulation and, if necessary, commutation. Special Acts were passed for Burma in 1851 and for Madras in 1852; they were drawn up on the same lines as those of the Indian Forest Act, but provided for the special requirements of these two provinces.

Under the provisions of these Acts, numerous rules were passed in the several parts of India. Previous to 1878, a considerable area had been selected and entered as Reserves, but their legal standing was uncertain. The new Acts provided an authority to recognise as permanent State Forests all areas in which a satisfactory enquiry and settlement of rights by third persons had been made; in the rest of the areas new settlements had to be made in the manner prescribed in the new Acts. Great activity was shown in the matter, and at the end of the year 1854-55 there were 49,214 square miles of permanent Reserved State Forests and 13,103 square miles of Protected Forests established under the provisions of new Forest Act. At the end of the year 1897-98 the areas of Reserves that increased to 81,414 square miles and that of Protected Forests had decreased to 8,815.

I may add that by 1919 the areas were 101,639 square miles of Reserves and 8,557 square miles of Protected Forests, while a further area of 141,272 square miles of forest were as yet unclassed, making a total of 251,468 square miles equal to 23·3% of the total area of the country. The delay in passing the Indian Forest Act was chiefly due to a difference of opinion on the question of legalising only reserved or both reserves and protected areas. Experience has decided in the favour of reserves.

The next subject to which I wish to draw attention is the survey of the forests and the preparation of maps. The Departmental Survey Branch was established in 1872 and placed under Captain Bailey, R. E., with Mr. W. H. Reynolds as principal assistant. The latter took charge of the branch in 1883. The branch developed great activity, so that the area actually surveyed and mapped amounted in 1898 to 46,159 square miles; by 1919 it had further increased to 85,906 square miles.

WORKING PLANS.

From the very beginning of his activity in India, Brandis drew up what he called preliminary working plans always based on the principle of a sustained yield for the forests which he

visited. These plans were generally accepted as guides and acted upon, until more detailed information became available. As more professionally trained officers became available, the collection of statistics and the preparation of working plans became more accurate, but no regular prescriptions for their preparation had been worked out; nor was there any proper control over their future execution. However, the results were fairly satisfactory as long as the forests were Imperial.

In 1852, however, the forests were decentralised. As a consequence, the Government of India fell out of touch with the exploitation and management of the forests generally, while in many cases the forests were in danger of being overworked. I was Inspector-General at the time, and proposed to the Government of India to centralise the control of the preparation of regular working plans and their execution, and to place the new branch under the Inspector-General with an Assistant Inspector-General in charge. The proposal was approved by the Government of India and sanctioned by the Secretary of State for India in 1854. Ribbentrop, in his "Forestry in British India," writes: "This was one of the epoch-making events in our forest history." The preparation of working plans continued to be carried out by local agency and under orders of the Local Governments, but under the technical advice of the Inspector-General of Forests, who examined and criticised a plan and forwarded it to the Local Government with his recommendations. In case of any difference of opinion, an appeal could be made to the Government of India for a final decision. The machinery worked smoothly, and there were no appeals to the Government of India up to the year 1900. It was said at the time that ultimately each province was likely to require its own officer in charge of working plans, and this has now actually come about. Under these regulations 20,000 square miles of forests were worked under approved working plans in 1900, and the area had increased to 60,670 square miles in 1919. Annual returns are received by the Inspector-General which enable him to watch the progress of working and to take the necessary action in case of deviations from provisions of sanctioned working plans.

That great man, Sir Dietrich Brandis, left the Government of India in 1851, proceeded on special duty to Madras, where he drew up a full report on the forests and brought about the passing of the Madras Forest Act. He finally retired in 1853.

I should have liked to deal with many other matters, but I must not make this article too long. The general administration of the forests was improved throughout the period of 1870 to 1900; their silviculture was diligently studied, but the results are unfortunately scattered over an endless number of reports and working plans; a system of protecting the forests against fire (alas! in some cases they are purposely burnt!); the work of the forests (exploitation) by the department, contractors and lessees has been regulated, and the utilisation of minor produce developed; and many other matters.

I think I have placed sufficient evidence before the readers to show that excellent work, including new methods, was done during the period of 1870 to 1900. By the latter date, the spade work was complete, the Indian forest estate stood erected on a safe foundation, ready for further development. And it did come in great volume and rapidity, making the period of 1900 to 1925 one of intense interest. I hope that I may yet see an account of it in the pages of the *Indian Forester*.

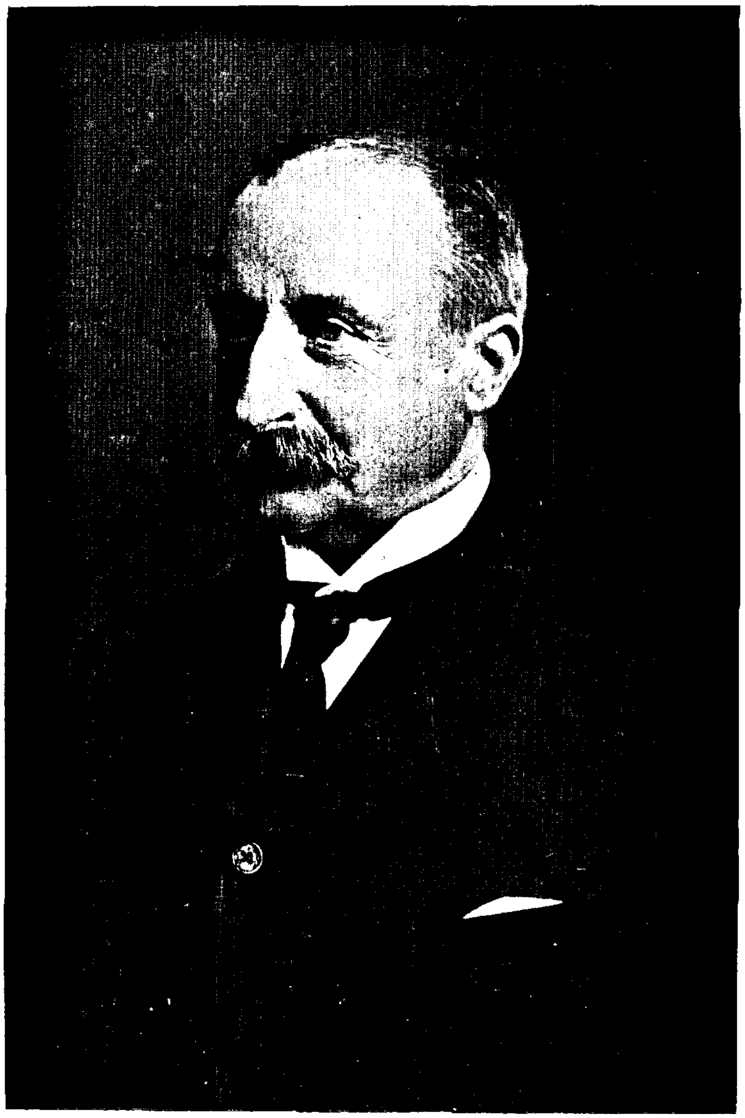
Oxford, May 1925. W. SCHLICH.

SOME REMINISCENCES OF THE 'SEVENTIES.'

I have been kindly invited by the Editors of the *Indian Forester* to give some account of my experiences of early times in the Indian Forest Department, so I will make an attempt to write something of the kind, though I fear it will not be very interesting. Forest work in the early days was hard and continuous, the distances were huge, roads and conveniences for travel scanty and most of us were chiefly employed on the preliminaries—selection, demarcation and settlement. The preparation of working plans and the study and application of silvicultural principles only came later.

TRAINING IN FORESTRY, 1869—1871.

I was one of the men selected for training in 1869. We were seven in number, four of us went to France and three to Germany. The four of us, Messrs. Whittall, Pett, Wroughton, and myself went to France and we were placed for about the first six months under the Inspecteur of the great forest of Haguenau in Alsace, M. Clément de Grandprey, a most energetic and inspiring chief who worked us pretty hard, out all day and every day, doing work in the forest exactly as if we ourselves were "Gardes Généraux" belonging to the staff. We consequently learnt, in those few months, nearly all the details of practical work and the important points of silviculture and working. The forest of Haguenau was a varied one ; besides the large area of Scots pine (the celebrated variety, the *Pin de Haguenau*), there were considerable areas of oak with hornbeam, many pieces of mixed coppice and even willow woods on the Rhine banks. We amused ourselves, when occasionally off duty, with small football in the town moat to the amazement of the young Alsatians and were able generally to spend our Sundays in Strasbourg, the English Church in the morning and Grand Opera in the evening ! It is curious, in these expensive times, to remember the cheapness of life in the little old Alsatian fortress. I had a good bedroom and sitting room in a house looking over the town wall for which I paid 25 francs a month, and we paid, if my memory is quite accurate, each only 27



J. S. GAMBLE, C.I.E., F.R.S.
1871—1899
Honorary Editor of the Indian Forester, 1878-1882 & 1891-1899.

francs a month for our *dèjeuner* and dinner, including small Riesling wine, at the Hotel de la Poste, where we met the officers of the small garrison and the chief civil officials of the town. The officers made us members of their Cercle or Club, where we chiefly spent our evenings. It was a very pleasant time on the whole and enabled us to learn the language pretty well before we left for the Forest School at Nancy at the beginning of their term.

The course at the Forest School at Nancy was one of two years. We joined there in October 1869 just in time to meet the four of our predecessors who were appointed in 1867 and were just about to leave for India. They were Henman, Pengelly, Dasai and Moir, the last of whom is now the sole survivor and still going strong, I am told, just as I am, unfortunately, the sole survivor of our own year. We joined [the 46th 'Promotion' and found ourselves in company with about 30 young Frenchmen with whom we soon made excellent friends. The Director of the School was M. Nanquette, the Forestry Professors Bagneris and Broillard, the Natural History Professors Mathieu and Fliche; Forest Engineering and Surveying were taught by M. M. Barré and Roussel; Forest Law by Meaume and Puton. The winter months were entirely devoted to lectures so that life was not very eventful, though it was enlivened by an amusing quarrel with the senior year, the 45th, which began in the riding-school and ended in our secession from the "Cercle" to a club of our own. The riding-school was always interesting, some of our fellow-students, country-bred, were very good, but those who came from towns were mostly very poor horsemen. We four were all right and enjoyed the semi-military rides in the country and were also glad to hire horses on Sundays and join some of our French friends in excursions, usually out to the Moselle valley. Once we four got into terrible hot water by all cutting lectures and going to skate, a hard frost and a frozen canal proving too attractive. In the spring, outdoor work began and it was quite a pleasant time and still more so were the long excursions to the forests of the Vosges and Jura.

It was when we were all down in the Haut Saône that the war with Germany broke out, in July 1870, so we had to return

in haste to Nancy for the French students had all to go and join up at once. I and an Italian, Bouquet, also an outside student, were the last to leave and being then free I made my way down to Strasburg where I nearly got into trouble by paying a visit to the Rhine bridge which had been blown up. However, they thought me only a mad Englishman, but I cleared out and went down to Switzerland by almost the last available train, the very disastrous news of the first battle, Wissembourg, having arrived. In Switzerland I joined my brother who was mountaineering but as I cared little for climbing peaks, I found greater interest in collecting alpine plants and eventually, after a visit to works in progress at the Mount Cenis Tunnel, we wandered through Northern Italy and across the Adriatic to Trieste and Vienna and so up the Danube, when I was recalled by the India Office and sent with the others to Scotland.

There we met the men of the next year who were at the St. Andrews University. They were Fisher, Hill, Hutchins, Dickenson, Dansey and Greatheed, all of whom I regret to say and so far as I know, have since passed away. We four lodged with Dr. H. Cleghorn (formerly Conservator and acting Inspector-General in India) in Stravithy and we chiefly spent our time trimming his hedges and thinning his copses, with, during the winter, plenty of skating and curling. But we paid very interesting visits to the forests of Scone, Dunkeld and especially Strathspey, where, under the guidance of that fine old Forester Mr. Grant Thomson, we were able to study the old forests of natural Scots pine.

When peace between France and Germany was signed, in the spring of 1871, we went back to Nancy, where as the Germans were still in occupation; things were rather different, but lectures and forest work went on as before. The end of the course came in October and we then received our orders for India.

I must not leave my short account of the Nancy training without remarking how excellent it was, not only in the lectures for the eminence of the several distinguished Professors was enough to guarantee that, but also in the field for much of the work was not only in being shown things but in having actually to

arrange and carry them out. Personally, I can testify to having started my interest in wood-structure under the auspices of Prof. Mathieu and with the help of the well-arranged collection of woods in the wood-chalet in the School garden, so that I was able at once to carry on my interest in the subject when I got to India. I can also recall with much pleasure the friendships made with our French fellow-students, some of which lasted for many years in correspondence and occasional meetings. The Nancy training went on for several years, but eventually the number of British students got too big and other arrangements had to be made. To have learnt to talk French fairly well was not the least of the advantages we got from our time at the National Forestry School.

In November 1871 we started for India. I was ordered to report at Calcutta and I was told by the India Office to take out Wardian cases of *Ipecacuanha* plants for the Botanic Gardens and for the arrangements about them I had to visit Kew and, under the guidance of Sir Joseph Hooker, pay my first visit to the Gardens and Herbarium of which I was destined later on when on furlough and at the present time to see so much. The great difficulty about cases was to prevent salt water getting into them when the decks were being washed and it was by no means a sinecure. The transit from Alexandria to Suez was also a difficulty. Wroughton and I shared a deck cabin on the P. & O. SS. "Nyanza" the last of the paddle steamers of the Company. We were opposite the cow and the poor old thing had very bad time in a storm off Algiers. The Suez Canal was not yet completely opened for traffic, as indeed it was not for many years later, so we had to go to Suez by rail and shift on to the "Sumatra" for Point de Galle and Calcutta. I duly delivered my cases at the Botanic Gardens, landing at the private Ghat from which, curiously enough, I was to take my last departure 28 years later on.

WORK IN BURMA.

At Calcutta, I received orders for Burma and went down to Rangoon in an old coasting boat the "Busheer" visiting the beautiful harbour of Akyab on the way. At Rangoon there was

no hotel, the Dâk Bungalow was only used by people with their own servants and at the Forest Office I was merely greeted with the hope that I should find somewhere to put up, but I luckily had private letters of introduction and was made quite comfortable. The Conservator, Col. W. Seaton, was away on tour and I had to wait sometime before I could get his orders, but to a new-comer it was a very interesting delay spent in walks about the country and in watching the " Hathis pilin' teak " in the Kemmendine timber depôt. Orders came at last and I was sent up the Irrawaddy to Myanoung, the then Headquarters of the Tharrawaddy Division. The Divisional Officer was Major W. Douglas, who had been recently transferred from Berar where he had done much good work. It was fortunate that he was an old friend, as when on leave a little while before, he had spent a month or so with us at Nancy to see what the Forest School work was like.' He was rather out of it in Burma and regretted his life in Central India, and here I may as well quote what Col. G. F. Pearson wrote to me about him in 1903 :

> " I must write a word to tell you of the very great pleasure it gave me to read your kindly mention in the *Indian Forester* of November of my great friend and brother officer Douglas. It was indeed a pleasure to me to know that a kindly recollection of him still remains with others who knew him, as well as with myself. When he first joined my Regiment he came to live with me and did so, I think, till I left, and the friendship I then made with him and the trust I felt in him, made me offer him one of the Forest appointments that were placed at my disposal when I was made Conservator of the Saugor and Nerbudda Territories (as they were then called) and well he repaid the confidence I had in him."

Myanoung was quite a pleasant little station with houses on the river bank, but the society was small. There was an Assistant Commissioner, Capt. James Butler, an Executive Engineer and three other Forest Officers, Nugent Daly, Assistant Conservator and Messrs. G. Stratford and A. L. Hough, Sub-Assistants, these

two last employed on the linear Valuation Surveys for teak which had been started by Dr. Brandis some years previously, Daly chiefly doing girdling work. I was, of course, attached to the office to help Douglas with the accounts and the correspondence. There was a great deal to be done for the contractors' accounts and the ledgers were in anything but a satisfactory condition, and I am glad to say that we soon managed to get them straight and then I had to make frequent visits to the Judge's Court at Menghee some way down the river to take out warrants against defaulting timber contractors who had taken advances and borrowed elephants and failed to bring out sufficient timber to clear their accounts. The Judge was Capt. C. J. F. S. Forbes whose book "British Burma and Its People" was published by Murray in 1878 and may still be read with profit by those who desire to study Burmese customs and mentality. I soon learned to talk fairly well and to read the petitions which came into the office; certainly the Burmese writing is much easier to read than the scrawls of Urdu and Hindi 'arzis' of Northern India.

During the rainy season of 1872, Douglas took me with him round the Division as he had to inspect the works on the floating streams, where, especially on the Shwelay, quantities of timber had got neaped and had to be salved with elephants. It was all very interesting but it was disappointing that we could not get much into the forests at that season. We could not take tents but had to put up with the poor accommodation of a few rough forest huts or the roadside 'zayats,' shelter sheds, often affording very poor shelter indeed. Nor could we take ponies so we had to travel on elephants sitting on top of our luggage. The treasure chest was a great trouble: there were many payments to be made and all of them in silver, so the chest had to be fastened at night by chains between our bedsteads.

I shall never forget the last day's journey from Thongzé across to the river bank opposite Henzada, the District Headquarters, for the whole way was either through long grass or flooded forest and the mosquitos and gadflies swarmed in myriads and the biting red ants dropped off the trees. It was nearly

dark when we got to the river which was in flood and had to be crossed in dug-out canoes dodging the logs and drift timber.

When all the Staff were in Myanoung during the rains, we had more society: the four of us juniors were allowed to occupy four small rooms surrounding a big one in the Circuit House on condition that we turned out if the Commissioner or Deputy Commissioner came. My companions were all excellent company especially Nugent Daly, a big Irishman, with a brogue. When the dengue fever came, the three of them all got it, so it was left to me and the Myanoung apothecary to look after them, but some of the remedies tried were more curious than effective.

George Stratford had a mania for minute geography, especially for towns. He had never been either in London or Dublin but neither I nor Daly could succeed in stumping him with a suggested journey. He left the service soon after I left Burma and I believe he afterwards held a good position in the Police in Devonshire. Hough also soon left the Forests, transferred to the Commission, and I rather think he ended up as a Commissioner.

Myanoung was surrounded by rice fields swarming with snipe, and though I worked with great assiduity I never succeeded in learning to shoot them. Sometimes Daly would come out to see how I was getting on and he would say "Sure you're no good at all, give me the gun," and then he would proceed to knock them over, one after the other, hardly ever missing, till we had enough for the four of us.

There were several Forest Officers in Burma, that I have never met. Col. W. Stenhouse, Mr. Adamson, two Germans or Dutch, Slym at Moulmein and Elsner at Prome, the latter a rather eccentric person of whom there were many stories that I have forgotten.

There were two great events in the week, the visits of the up and down stream steamers bringing the weekly post which gave the office a few days hard work. We always used to go on board to see the Captain and perhaps get him to help our supplies by selling us a sheep and to greet any friends that were

on board. They were small boats with not much accommodation for travellers, and usually had two flats for cargo and native passengers. Sometimes special steamers belonging to King Theebaw went past, once a whole load of 'durians', the strong-smelling Malay *Durio zibethinus* of which the Mandalay Court was very fond. We got a few and found them quite good so long as we kept to windward of them.

For Douglas and myself the chief amusement was in rides in the country, a favourite one being out to a plantation of magnificent '*Wabo*' bamboos (*Dendrocalamus giganteus*) with culms nearly 100 ft. long and 9 in. diameter. I do not know whom it belonged to, it was not to Government, and I have often wondered what became of it. On one occasion, Butler and I spent two or three days in a visit to a lake at the foot of the Arakan Yoma hills, to shoot duck and see a rather fine bit of teak forest. I think I spent the coldest night I can remember in a bamboo hut well raised off the ground on that occasion. I suppose we took only thin clothing and insufficient bedding.

One of my duties was looking after the Government elephants that were kept across the river. I think there were about 30 of them and they all had to be examined for sore backs and feet. An unpleasant experience was the duty of seeing a dead one cut up and buried, and the tusks cut out. Burmans, who would have liked to eat it, wanted to buy it, but it had to be buried or burnt under orders of Government to avoid any chance of disease. I shall never forget the stench at the operation! A storm had prevented my crossing the river till it had got very 'high'.

WORK IN BENGAL.

In August 1872, I received orders for transfer to Bengal. It was not at all a welcome order for I had got interested in Burma and wanted to stay there, but I had to go and that just before the language examinations qualifying for a rise in grade and pay from Rs. 250 to Rs. 350 a month, the rates of those days. But it would not have mattered because of the influence of the many ex-army officers in the Department had succeeded in getting

the Government of India to make a rule prohibiting promotion for trained men until they had been three years in the country, a rule that operated very hardly about a year or two later when some of us, myself included, who had been promoted in our Provinces, were made to revert and repay extra pay drawn. How would junior assistants of recent years have liked to spend three years on Rs. 250 a month? Some of us were much tempted to strike and seek work elsewhere and I myself was once sounded as to a possible change to much better pay in the Education Department but decided to stick, for the sake of out-door life, to forest work. I think Dr. Brandis must have got the rule cancelled when he returned from leave in 1874 or 1875.

On my departure from Rangoon there was rather an amusing scene. My two Burmese servants wanted to go too, desire to see more of the world perhaps, but was told it was not possible. They disappeared after my luggage had been put on board and were eventually found hidden and had to be sent off on shore. Poor fellows, they were nice boys and I missed them very much during my first three months or so in the new Province.

In Calcutta I was told that the Lieutenant-Governor, Sir George Campbell wished to see me. It was the year before the regular visit to the hills began which was in 1873 and he was then visiting riverside districts in his yacht the "Rhotas," so I went to Bhaugulpore as ordered and spent a pleasant week at the Dâk Bungalow opposite the Ghat where the "Rhotas" was tied up. Sir George Campbell was very kind and said he wished me to go up to the Darjeeling District and visit and report on the plantations both in the hills and the Terai. I also met Mr. (later Sir Charles) Bernard the Chief Secretary and had several pleasant morning walks with him in the neighbourhood. I had seen the Conservator, Mr. H. Leeds, in Calcutta, and had been told that my definite appointment for work would come later, as it did after the Plantation Report had been sent in. The chief plantation to be reported on was that at Bamanpokri at the foot of the hills below Pankabari, so I made my way there crossing from Sahibganj to Caragola and doing the long journey to Siliguri by Dâk Ghari through Purneah and Kishenganj all new and

interesting country. The Forest Officer in the Terai was Mr. James, a Sub-Assistant, and he met me and helped me out to the plantation.

It was an attempt to introduce teak into the Terai forests, in which the Bengal Government was much interested and it had been successful though expensive on account of the necessity for clearing out the long grasses which covered the site and for the frequent cleanings necessary to prevent their regrowth and the establishment of useless and undesirable trees and bushes. In succeeding years, the plantation was extended and the trees did well but it was finally given up, probably because there was a better market for *sal* and other trees, especially those useful to tea planters. Mr. Shebbeare has, however, recently told me that since 1917 a kind of renewal of interest in teak growing has sprung up and that it is being grown here and there in the *taungya* plantations in the Terai. He also tells me that the "most striking thing about the plantation now is its freedom from undergrowth" especially that of evergreens which are so noticeable in fire-protected areas. Some of the trees have girths of 4½ to 5½ ft. and even 7 ft., but the natural *sal* have had a tendency to suppress the teak.

The other chief plantation was at Rungbool on the slopes of Mount Senchul above Darjeeling at about 7,500 to 8,000 ft. altitude. The needs of the then comparatively new hill-station and its Military Cantonment had caused the felling and conversion of a large area of old virgin forest of oaks, chiefly *Quercus lamellosa*, Chestnuts and Magnolia (*Michelia excelsa*, chiefly) with other big trees and the object of the plantation was to restock this area. The work here, too, had been expensive because of the need for keeping down the tangled growth of brambles and shrubs and small trees of no value, whose dense growth, as was to be expected in a locality where the rainfall was often 250 in. in the year, prevented the planted trees from growing. On both these plantations I wrote and submitted a Report.

In 1872, Assam was still a part of Lower Bengal but the forests were administered by the Commissioner with a Deputy Conservator of Forests Mr. G. Mann in charge of all except the

districts of Goalpara and the Garo Hills which with the districts of Jalpaiguri and Darjeeling formed the Cooch Behar Division. The districts of Sylhet and Cachar formed a Dacca Division but there was no Forest Officer in charge. Towards the end of 1872, Mr. Leeds was transferred to the Central Provinces and the new Conservator was Dr. W. (now Sir William) Schlich who had been Conservator in Sind. It was fortunate for Bengal to obtain a Conservator of Dr. Schlich's capability and he proceeded at once to reorganise the work of the Department. The Cooch Behar Division was placed under Capt. C. W. Lossack, Deputy Conservator, while I was appointed under his orders to take over charge of the Darjeeling Sub-division, from Mr. James. At first, Capt. Lossack looked after Jalpaiguri and Mr. W. Shakespeare the Goalpara Sub-division.

The first work we had to do in the Cooch Behar Division was to rediscover the boundaries of the Reserved Forests which a few years of neglect had caused to be overgrown with jungle. Then we had to begin stock-taking by means of linear valuation surveys, and at the same time to collect and bring out for sale a great deal of cut *sal* timber which the Government had to take over from a defaulting contractor. This was hard work but interesting, especially in the valley of the Tista river where we succeeded, with the help of a gang of Nepalese boatmen, in bringing out, in bamboo cradles, nearly all the cut logs from some distance in the hills, and in extracting from sandbanks in the lower river many that had got waterlogged and sunk and gradually worked their way down. For this work, of course, elephant help was necesssary.

The logs were nearly all taken over by the Public Works Department or cut into sleepers for the Northern Bengal State Railway, then being constructed. The system of sale of trees in the hills was a very makeshift one in those days. There was a fixed rate per tree for different species and the purchaser paid his money and obtained a permit, upon which the Range Officer proceeded to mark his tree and he felled them and cut them up into firewood or timber as the demand was. The system had to go on for a few years until the Staff was improved and better arrangements could be introduced.

In 1874-75 the Cooch Behar Division was divided up, Darjeeling and Jalpaiguri being made separate Divisions and Goalpara going to Assam; and in 1877-78 a new sub-division took place so that the two Bengal Divisions became five and the improvement caused by additional officers, a better Range Staff and more business-like systems of working, was very great. So far as I know, the arrangement of divisions then settled still exists and it is not too much to say that the credit of the satisfactory organisation of forest work in Northern Bengal was due to Dr. Schlich's admirable arrangements.

I was myself in charge of Darjeeling till it was sub-divided and was then transferred to be Assistant Inspector-General of Forests. I can therefore close my little account of experiences during my first years of work in the Indian forests. My chief feeling, in looking back over those few years, is that I should like to go through it all again.

Liss: *March 6th*, 1925. J. S. GAMBLE.

REMINISCENCES OF THE CENTRAL PROVINCES FORESTS.

My connection with these forests dates back to 1888, when on transfer from Ajmer I arrived at Nagpore, and found orders awaiting me to report myself at Raipore. As the Conservator was on tour I went on at once travelling by the Chattisgarh State Railway—a meter-gauge railway which had only been constructed as far as Rajnandgaon; this line I may mention on being handed over to a company was dropped, and along it now runs the present Bengal-Nagpore Railway. On arriving at Raipore I found orders awaiting me to proceed to Sihawa, and to take up the demarcation of the *sal* forests. The first part of the journey was through poor mixed forests, which all over showed signs of being badly knocked about, and in addition to this there were signs of yearly fires. Along the road some ten miles from Sihawa one passed through stretches of *sal* in a pole stage. The whole of this *sal* forest was from coppice shoots the result of *dhya* cultivation, which had been carried on for years, and even when I first saw it was being carried on over a small area along the south-west corner of the district. At Kalameta I came to the point from where my work of demarcating the *sal* forests was to begin. This took me close on to three months to complete.

I got back to Raipore about the middle of June and found orders awaiting me to take over charge of the Seoni Division from Capt. Lossack, who was retiring. When the rains were over I took over charge of the Khandwa forests. I found that there was a very large area of "B" Class forests along the Tapti valley which had to be tackled to see what had to be kept as forest and taken on to the "A" Class, and what had to be disforested. A very large area of the "B" Class disforested was soon under cultivation and now not a trace of the original forest is left. In the Khandwa forests I spent a very happy time of nine months, specially in the Punassa and Chandgarh forests. These forests are of a mixed type with a fair sprinkling of teak in a pole stage nearly all over, but better in parts of the Chandgarh forests,

FOREST CONFERENCE, ALLAHABAD, 1874.

J. McKee, H. Calthrop, B. Browne, S. Kurz, A. T. Drysdale, F. D'A. Vincent, G. F. Prevost, H. Leeds.
T. Lewin, W. H. Reynolds, J. C. Doveton, R. Ribbentrop, A. E. Wild, J. S. Gamble G. G. Minniken.
W. Schlich, B. H. Baden-Powell. E. M. Playfair, J. Macleod Campbell.

along the Nerbudda river, which divides the Punassa and Chandagarh Ranges. It was in the Punassa forests, that I first met the *Anjan* (*Hardwickia binata*).

Game was plentiful in the forests and it was from the Punassa bungalow that I first shot my Bison. "Khabar" was brought me that a large sounder of pig were in the tank close by, and as they were keen for the meat, I started off with my double ·500 rifle with a few soft nose cartridges in my pocket. On getting to the fireline by the tank I got a few men to beat towards me through the long grass. I had not very long to wait when out came two large animals across my front, and only a few yards from me. I fired a right and left and was fortunate enough to drop both, in each case with a broken neck. Though the horns were not of any great size they were both young bulls. It was a great piece of luck. I was very sorry to leave these forests just as the forest work and shikar were getting most interesting.

From Khandwa I was ordered to take over the Chanda Division from Foster, who was leaving for Coorg. I got to Nagpore early in June and met the Conservator, Col. Doveton, a dear old boy but very indifferent where forest roads and quarters for officers and subordinates were concerned. Many a time did I get into trouble about this. When asked about the construction of a bungalow, "Why, is not a grass shed good enough for this" was the prompt reply. Of course in those days there was only one Conservator for the whole of the Central Provinces and no Chief Conservator. I have no hesitation in saying that Col. Doveton, who was a thorough gentleman and forester, did quite a lot for the forests of the C. P. and may his memory live.

In June 1889 I arrived at Chanda, my new charge. On leaving Nagpore I was bid many loving farewells as the climate of the Chanda forests was considered to be very bad. True I was fairly ill for the best part of two years but thanks to an overdose of Ipecac which the Doctor gave me by mistake when I nearly disgorged my liver I took a sudden turn for the better. We were out in camp together and I was in bed for few days, but on rising I never had a solid day's fever from that date to this—Touch Wood!

The Chanda Division as I knew it consisted of over 3,000 sq. miles. I arrived just as the rains broke and found myself confronted with a new language, Mahrati, and as all the work was carried on in that vernacular I had to set to and master this. Fortunately it was not a compulsory language and I passed by the higher standard and scored Rs. 500.

During the rains I was asked to start the revenue stamp system. This consisted of sitting down for many hours during the day and getting these revenue stamps stamped with rubber dies on blank sheets of paper in different colours—the colours denoting the value of the stamp. These stamps were given out to vendors as is done now. This was the origin of the present stamp system right through the Province. The rubber printing of these stamps necessitated the most careful watch as thousands of stamps had to be turned out in a day. I used to get through my piles of vernacular papers with two munshis going hard while I kept watch over the stamping. The Division was divided into ten ranges most of them in charge of deputy rangers and not an English-speaking man among them, so the vernacular work was pretty heavy.

Being a rice district everyone advised me not to start too early after the rains into camp. By the beginning of November I started out to see what my huge Division was like, making for Allapilli, the cream of the forests, about 75 miles from Chanda. The roads were bad so that camping was in short- marches, through mixed forest, some of it quite good, but like the other forests in the Province, the signs of unnecessary cutting were visible everywhere. None of this area was under fire-protection.

On the seventh day I arrived at Allapilli, in the evening very tired and just fit for dinner and bed. I was ushered into the bungalow which I thought had been got up for me when they heard I was coming. I slept peacefully under the leafy canopy. Imagine my astonishment in the morning to find that the whole room was a mass of leafy branches. Posts of *Garuga pinnata* had been used and with wattle and daub ; the walls had been constructed with a thatched roof. True it was cool during the day.

I was not up long when I heard the sounds of the saw-mills at work where sleepers were being sawn up from the teak logs brought in from the adjoining forests. When ready they were carted to the depôt at Warora, the closest Railway station about 100 miles away over a very bad road. These saw-mills I believe were started by good old father Thompson. May his memory live for ever—a thorough woodsman, and what he did not know about the forests and all its crafts was not worth knowing. He was my "Guru" in shikar and he taught me a lot. Many a time while in the forest together have I been pulled up to listen to the twitter of a bird, or the call of an animal, unfamiliar, he then told me the life history of the bird or animal while we moved along.

An interesting story was told me by Mrs. Thompson about her pet python. The snake used to live in an earthern pot (a *gharah*) of some size. They had had the snake for a couple of years and it had grown fairly big. The Thompson family used to go down to Allapilli in December and stay there till June, when everything in the shape of grain was locked up in *gharahs* in a godown, with the mouths of the pots closed up. That year on their return from Allapilli, some rice was wanted, so Mrs. Thompson went to the godown and thinking she had got hold of the pot that contained rice opened it and out popped the python. For six months he had had no food or water and had changed his skin once.

After having inspected the saw-mills and the very fine teak forests of Allapilli and having shot four tigers I moved down towards Sironcha along the Godavery River. In those days the Cherla and Albaka talukas across the Indravati River, were attached to the Sironcha Range. These have now been handed over to Madras. There were some very fine *Hardwickia binata* in sandy areas chiefly. I have been along the Indravati River; right from where it leaves the Bastar border down to where it joins the Godavery. The scenery all the way is very fine, in places reminding one of small lochs; open stretches of water with low hills behind, and fringed with a small *Eugenia* to take the place of the weeping willow. It was on the Sironcha forests in

1890-91 that I first came across the flowers of the "Kattang" (*Bambusa arundinacea*). In January 1921, I was able to note that it was in flower and seed again. I happened to be in Chanda that year and saw all the "Kattang" in full flower, just 30 years since I saw it last.

When I came to Chanda there were no English-speaking Rangers. Communications were bad, we had very little in the way of fire-protection, and practically no Working Plans, Chanda was quite at the back of beyond. There was no Telegraph Office nor Railway. The revenue was practically stationary. Gradually, I saw all this change. I had more than one assistant and some first class Rangers, our present I.-G. of Forests being my Assistant, the best of the bunch that I saw, though it is I that give the certificate.

There is one little story that occurs to me, I believe in the shooting of his first tiger. We had had a kill at Allapilli and he had a machan up and sat for the tiger; towards dusk the animal walked down and he fired. No sound from the tiger and no tiger. When he got back he told me the whole story to which I remarked that either he had shot it through the heart or missed clean. With this cold comfort he went to bed. We started very early in the morning on a pad elephant and went to the spot. I was seated in front and he behind, when all of a sudden I felt a push from behind followed with the exclamation "There he is;" and there he was not 20 yards away with a shot clean through his heart.

To follow on, the working of the forests had developed. The Ranges were formed into Sub-Divisions and 5 Sub-Divisions with ten Ranges going. My stamping of Forest Stamps took form, which was a comfort, and the present Revenue stamps were introduced. Working Plans were being hurried on; fire-protection increased and roads repaired. All this meant an increase of revenue all over the Province, even as far back as 1900, when there was a bad check in the famine. The rains stopped early in September and both the *Kharif* and *Rabi* crops went at one swoop. Government was not prepared for it and were tied up in a bad muddle. No programme of works had been

got ready. Fodder for cattle outside forest limits was scarce, so that grass cutting and baling had to be taken up on a very large scale all over the Province. This gave employment to many thousands of people, all being paid in kind. This entailed heavy work to see that the grain shops were kept supplied. Other works such as tank construction, road making, etc., were hurriedly started while the people in a famished state were flocking in. I got sanction to run my own show, while the grass cutting operations were under the charge of Sub-Divisional Officers. I hurriedly did the alignments of some roads and selected sites for tanks. Fortunately. I picked out my best Ranger and he did yeoman work. He was a Mysore man as straight as a die. Between us we ran the whole of the forest works. At one time I had over 19,000 people along one end of the works. It was no easy task. I had made medical arrangements for this big undertaking and even when cholera broke out and I also was down we weathered through with few casualties. When the cholera broke out in my camps to my joy a Doctor man from Burma joined me for a shoot, but it was little shooting he did—sheer good hard work in attending to and treating the sick.

There was some difficulty in getting funds for seed grain and clothing for my Forest Villagers. To get over this I got the names of Shikaris for years back who had come into the Division to shoot, so I wrote them and I collected quite a good sum. But now the difficulty arose as to where we were to get the seed grain. My assistant on famine work, whose home was at Mysore, soon arranged for this and we got over the difficulty and everything went well.

There is one point I would like to note in this famine year with reference to the gregarious flowering of the small bamboo (*Dendrocalamus strictus*); over an area of 1,500 square miles the whole of this bamboo was in flower. Of course it helped to feed the people. Thousands were collecting the seed daily, men, women and children. This was a regular Godsend to the villagers.

I cannot help mentioning a small episode in shikar that occurred at this time. I was encamped at a place called Johagaon where there was a large stretch of this bamboo seeding.

Khabar was brought to me of a tigress that was giving trouble to the people collecting seed all round. I had a young buff tied out and promptly got a kill next morning. Though I was ill at the time I went out and soon got a shot and wounded her. A herd of buffaloes was collected and I followed in the rear. They had not gone far when the herd made a mad rush back right on the top of me. I was standing close to the stump of a large tree about 5 ft. high; my dear old Shikari Antu hustled me behind this stump and got along side just in time to escape being trampled as there was no escaping. I then followed up the tigress on foot as the jungle was open bamboo. I found the tigress quite a big one (8′ 6″) seated under a bamboo clump. She was a bit of a cur and one shot more laid her low.

Before completing my notes on the Chanda forests I would like to say a word or two on the destruction of deer and other small animals in the forest. It is with sorrow that I have seen the increase of gun licenses to would-be shikaris in a district. It has been a wrong policy from the very beginning and the results have reached a stage when man-eating carnivora have increased largely and the deaths from these animals have gone up. One would naturally ask, "but how is this since the benevolent district head, much to the disgust of his Forest Officer has increased the gun licenses in his district?" The answer is a very simple one.

1. The would-be shikari with his gun, be it what it may, sits over a water-brook and slays all deer and pig, regardless of sex or size, that come down to water. I once had the opportunity of seeing one of these men sell the meat of a sambhar for Rs. 15 and then there was the skin of the animal to be disposed of. It was a large female in young.

2. To help the would-be shikari we find the red dog who live on deer and pig in the forest. He is found in every district and as we all know hunts in packs, a perfect terror to the unfortunate deer. Between these two I have seen the destruction going on and now game as we knew it, is scarce in the way of deer. The red dog is still there and has got to be fed every day, if not every second day. To show how fierce and persistent they are I will

recount a scene that I saw, which in this case was to the advantage of villages. I was encamped at a village and had sat down to dinner in my nighties when I heard a tremendous noise in the village and saw torches moving about. On enquiry I found that a bad man-eating panther had come into the village and had been driven out. I hurried up with my rifle as there was a fair moon up. While questioning the men most ghastly screeches came from below us which we hurried up to and had not gone 100 yards when I saw four red dogs on the bank of a nala, (there may have been more) and in the bed of the nala there lay the panther with one hind leg partly eaten.

3. To add to the destruction there is the jungle tiger who has got to be fed, but between the shikari and red dog his feed is getting less so he has got to take to cattle killing ; his cattle killing brings him in connection with the cattle grazier and this leads to one of the reasons for the tiger becoming a man-eater. One point more in the link and that is that cultivation has increased and cattle have got to go much farther from their villages and get their grazing. Another point which is by no means small is that during the Great War very little or no shooting was done by sportsmen coming from outside, this no doubt added to the increase of tigers in the Province.

I now come to the question of what might be done to remedy the situation. The licenses of shikaries *must* be limited. The reward on red dogs must be increased. The rewards on tigers should be taken back to the old scale and not wait till a tiger becomes man-eater. It was a mistake ever to have lessened it.

The head of a district must consult his Forest Officer in the giving out of licenses. The guns used by shikaries must not be pop-guns. Many of us have taken one or even three old bullets from under the skin of a tiger when shot ; this in itself often leads to man-eating.

The district headquarters should have at least a dozen rifles of the snider type ready to be handed out to well-known shikaries as soon as a man-eater or bad cattle killer puts in an appearance. Good organisation is what is wanted and the men sent out. If Government is not prepared to take these measures

it must suffer the consequences. I have long considered this matter and though it was difficult to launch out before I now do so. As time and space are limited I must omit my reminiscences of my ten years in the Raipore Forests before I entered, sad to say, the fossil stage. Many happy days have I spent in the forest, none happier.

Chhindhwara, C. P,

A. E. LOWRIE.
late *Deputy Conservator of Forests,*
(*Central Provinces, 1888—1912.*)

FOREST CONFERENCE, SIMLA, 1875.

E. E. Fernandez, G. F. Prevost, W. Dunbar, C. F. Elliott, G. Duff, W. R. Fisher.

W. Johnstone, G. L. Gibson, E. P. Dansey, E. S. Wood, G. Greig, J. C. Doveton, F. D'A. Vincent, A. Smythies, F. Bailey, J. A. McKee, R. Ellis.

G. Mann, W. Schlich, A. F. Shuttleworth, H. Thuillier, D. Brandis, J. Campbell Walker, G. J. Van Someren, W. Stenhouse. C. F. Amery, W. H. A. Wallinger.

A. Pengelly, C. Bagshawe, R. C. Wroughton, H. C. Hill, E. M'A. Moir.

THE INDIAN FORESTS REVISITED.

During a recent visit to Dehra Dun the Honorary Editor suggested that I might be willing to write a few words for the *Indian Forester*, which is to commemorate its 50 years of life. I had previously read the Editor's appeal for assistance to make the commemoration number a success, and had decided that a duty lay upon us all in this matter. Having myself been associated with the magazine as Honorary Editor for several years during the first decade of the present century I was fully cognisant with the duties and difficulties connected with the monthly issue.

My promise to the Honorary Editor was, however, a conditional one. I was completing a tour round India whose objects had been to study the progress made in forestry management in all its branches, and more especially the achievements of the past 15 years, for that period had elapsed since I had left the country.

This tour, all too brief, since I had but three and a half months available in the country, has been one of the most wonderful journeys I have ever taken. Those of us at home who have maintained our interest in all pertaining to India, and more especially our professional interest in her forests, were of course aware that changes had been, and were taking place; that India was a new country and that anyone who had been away for a decade, or less even, would not recognise it as the country they had formerly served in. Personally, I am unable to subscribe to so drastic and dogmatic a dictum. Changes there are, political, professional and social,—but to a close observer some of these are not so marked as the retired Anglo-Indian official at home would have us believe. And, perhaps, out in the forests amongst our own forest people the changes generally speaking are even less apparent. What a pleasure it was to get back once again into the Indian Forests and to meet once again the jungle folk! They may be so exasperating at times, but what of the city, the industrial labourer? Try him for a time at forest work and you will soon count your jungle man as a ten-hours-a-day worker by comparison.

It may be, it doubtless will be, expected of me, to give in this article some of my opinions on the progress made in the forests in the different Provinces, since, it will be argued, "*you've just been round looking at them.*" *But this is just my* quandary! I have been looking at them, some of them. I had only just ceased doing so when I put my foot on the deck of this ship, from which I write. But I find it almost impossible to give any sort of an account of my impressions of the progress made. The tour was too strenuous and little time was available to sit down and correlate our impressions and notes into such a form as would enable a short summary of the tour to be written. It is quite possible, however, to state in plain language that the progress made in all branches of forestry is extraordinary, if the comparatively short period of years is taken into account. The extraordinary advance dates in most Provinces from about 1919, and during this period the foundation has been laid both in Sylviculture, working plans and utilisation, which, if the staff is maintained at a high level of efficiency, must have incalculable effects on the future value of the great Forest Estate.

What are some of the most marked features of the recent progress? I will cite a few—though each one is an epic by itself and therefore my reluctance to touch upon it in a brief article will be understandable. The order in which they are mentioned is merely that which I followed in my tour round the country.

The concentrated regeneration of *sal* by *taungya* at Sukna and elsewhere in the Kurseong Division in Bengal. I am myself a Bengal man. The solution of obtaining *sal* regeneration in these areas had proved an enigma for years. It has been solved and the same type of work was seen in the Buxa Duars Division. The wonderful exploitation of the forests in the Kurseong Division up at 7,000 ft. where a saw-mill and skidder are at work with a wire rope to carry the material 1,000 ft. down to the cart road and railway below. Then there is the exploitation work in Goalpara, with the miles of forest tramway including the 17 miles of good track from Kochugaon to the metre-gauge railway line. And Kochugaon and Haltugaon are now Forest Stations each containing a number of first class bungalows—the latter also has

street lighting! Twenty years ago there was a mud hut only at Kochugaon (it is illustrated in one of the volumes of the *Indian Forester*, 1906).

In Burma, a province where the prospects of forestry are vast and immeasurable, the Utilization Circle with its exploitation work at Tharrawaddy, the river training scheme so successfully undertaken, and the interesting work of the Circle at Rangoon are alone worth a visit to the Province. The recent aerial forest surveys carried on in the Delta and in the South Tenasserim evergreen forests are probably the first pieces of work of their kind ever attempted either in the East or anywhere else. Then there are the *taungya* areas up at Tharrawaddy and the interesting questions connected with Silviculture and Working Plans involved. And this work is on a high standard in Burma.

In the new province of Bihar and Orissa in the *sal* regeneration in the old Singhbhum Division (now sub-divided) the questions involved are most interesting for here the regeneration appears with facility. In the Central Provinces there are questions of extraordinary interest, but perhaps the most important is the question of expediting the preparation of Working Plans. One of the interesting things to see was the exploitation of the Allapilli Teak Forests in South Chanda with a road lead of nigh on 80 miles to the depôt. Among other most interesting examples of exploitation under which previously inaccessible forests are being attacked, is the wonderful work being undertaken near Olavakot in the Palghat Evergreen Forests. Here as in the case of the West Kanara teak forest the exploitation work is being accompanied by the regeneration of the areas exploited. It is impossible to do more than allude to these works.

Nilambur is providing some difficult problems in connection with the second rotation, but these interesting questions cannot be dealt with in a summary fashion. Nor would it be advisable to touch on those complicated forestry questions which have for so long had their place in the Thana Forests of Bombay. But it was of high interest to see the efficient method of felling and restocking the coupes in the valuable teak pole crops of this area.

In the United Provinces a mere enumeration of the areas visited will suffice, *e.g.* the Uniform System in the *sal* areas of the

submontane *sal* forests, where the question of obtaining the young *sal* natural regeneration is by no means yet solved in all cases; the Coppice method of regenerating in the Dun; the wonderful results attained in the same way in the Gorakhpur Division where everything can find a market; the commencement of *taungya* for *sal* in the same Division; and the really marvellous afforestation work at Allenbagh near Cawnpore and round Etawah, so different in character to the Irrigated Plantations of the Punjab. In the latter province Changa Manga is suffering from a fungus, but she has now two other areas of plantation which bid fair to prove a most valuable source of profit in the future. In fact it looks as if the importance of forest work in this province in the future will shift from the hills to the plains. Interesting factories such as those near Bareilly at Clutterbuckganj, a match factory near Lahore, proved of interest.

Lastly, there was the Forest Research Institute at Dehra Dun. Here again it will be useless in this article to attempt to deal with the Institute. One thing may be said. If we look back to 1906 when the Research Institute was founded, if we look back to 1906 those of us who were there at the start, if we then trace as closely as possible the progress of the Institute with the progress made in the advance of scientific forestry in the provinces, it may be said, I think, without doubt, that the coming of the Institute resulted in that advance which has placed forestry in India in many parts on a plane where it can vie in some of its practice with the best that Continental Europe can show. This is the opinion I have formed. I do not anticipate that, after a more complete and careful study of my notes and memoranda, I shall have to modify it.

In conclusion I would like to be allowed to express here my very sincere thanks to all my brother officers for the hearty reception they accorded me, the generous hospitality they showed me, and the ungrudging manner in which they worked both themselves and me, in order to render my visit as enjoyable and as instructive as possible.

E. P. STEBBING.

SILVICULTURE AND UTILISATION CONFERENCES, DEHRA DUN, JANUARY 1922.

Top row (left to right).	J. E. Macpherson, W. T. Hall, J. L. Simonsen, W. Raitt, T. S. Pipe, C. V. Sweet, H. C. B. Jollye, A. D. Blascheck, R. D. Richmond, C. C. Wilson,
Second row from top (left to right).	H. R. Blanford, W. C. Chipp, L. N. Seaman, M. P. Bhola, M. Cameron, G. E. Marjoribanks, J. W. Nicholson, C. Harlow, R. S. Hole, W. A. Robertson, A. Rodger, E. R. Stevens, H. Trotter.
Seated on chairs. (left to right).	R. S. Pearson, F. F. R. Channer, F. A. Leete H. G. Billson, P. H. Clutterbuck, W. F. Perrée, J. W. A. Grieve, J. R. McGiffert,
Seated on ground (left to right).	L. S. Teague, J. S. Owden, F. Canning, S. F. Hopwood, R. N. Parker, C. F. C. Beeson, S. H. Howard, C. S. Martin.

FOREST RESEARCH IN INDIA SINCE 1875.

The *Indian Forester*, which has been published regularly since 1875, contains in its 50 volumes a wonderful record of the observations of Indian forest officers. The most valuable of these are the articles written by foresters, often in the forest, recording what they have actually seen while wandering around the splendid forests of India. It is noteworthy that some of the best observers have been good shikaris, probably because the well-trained jungle eye, which can only be acquired by long and patient years of jungle travelling and observation, is specially developed by the shikari. Not all forest officers have the jungle eye, and it can only be acquired by those who not only know but love their jungles. Too often the jungle eye of the Ranger and Forester sees naught but the sand and pebbles on the path; and every Divisional Forest Officer must have marvelled to see how a beat officer must have complacently walked past a bad creeper on a valuable tree a thousand times without thinking of cutting it. Unfortunately many good observers are not good recorders, and it is sad to think how many millions of valuable facts have been noted in the forest but never written down.

The *Indian Forester* was for many years the principal means by which forest officers could publish their observations, as it is only of late that the numerous publications of Dehra Dun have been appearing, and Annual Reports were for long the driest dust of formula-ridden clerks. In the earlier numbers of the *Indian Forester* many articles deal with subjects which have of late years been intimately associated with Research. *Taungyas* are described at the very beginning and the impregnation of timber to preserve it from insects and decay was investigated in India actually before the *Indian Forester* appeared. In 1868 *Pinus longifolia* sleepers were treated with creosote at Aligarh (not Kaulagarh) by pneumatic apparatus, and it was hoped to sell treated sleepers at Rs. 3-8-0 each. It is noteworthy how much attention was paid to exotics such as *Eucalyptus* in those days, and other exotics which we now regard as of little import-

ance received a good deal of attention. Cutch, Burmese varnish, the value of annual rings, notes on rate of growth of *sal* and teak, the germination of seedlings, the effect of jungle fires, are all subjects which were investigated and written on in 1875—1880.

Kurz, the author of the "Flora of British Burma," contributed a very long and learned article on bamboos. Col. G. F. Pearson, the father of a well-known present-day forest officer, contributed a note "On the possibility of adopting the cubic foot of solid wood as the unit of measurement in the case of bamboos." This somewhat unusual line of thought, has not, as far as we have heard, been the subject of the investigations of the Forest Economist. It is difficult without a good deal of reflection to realise what forestry in India meant in those days. In 1875 one lakh was spent over the whole of India in fire-protection and Bengal spent Rs. 700 of that. Burma spent Rs. 683 on roads, and the whole area of Government Reserves in British India was 15,000 square miles, of which 26,000 acres was covered by plantations.

In connection with research in Minor Products it is worth recording that Dr. Brandis wrote in 1880......"Forest Officers in India should bear in mind that the increased production of wood and timber is not their only duty, but that the increased production of other valuable forest produce may in such cases be of much greater importance than the production of timber."

Three years after the *Indian Forester* was born, the Dehra Dun School, which has since about 1905 been intimately associated with Research, was started. At first only practical tuition was given, but theoretical instruction began with 30 students in 1881, and in 1884 the School came directly under the Government of India. Mr. Gamble, who was Director of the Forest School, produced his "Manual of Indian Timbers" in 1881, the first important publication dealing with forest research in India.

Since the beginning of the present century a strong spirit of investigation has developed in forest matters, and it has been felt that some arrangement for systematised and centralised research is necessary. A Forest Zoologist was appointed in 1900 and began to investigate the insects which were known to damage pines, *sal*, etc., but he did not by any means have the full sympathy

of the powers. It is related that a highly placed forest officer of those days was indignant because the Forest Zoologist had not produced any literature at the end of a year. The Forest Zoologist started directly under the Inspector-General of Forests, but in 1906-07 other Research Officers were appointed at Dehra Dun and the Research Institute began with a Silviculturist, Economist, Botanist, Zoologist and Chemist, all under the presidency of the Director of the Forest School. These branches still form the main divisions of the Research Institute, though they have developed largely. In 1914 a new building was opened where three of the five branches, and the Museums, were housed. The Botanist and the Chemist occupied separate buildings as they still do. Work progressed rapidly after 1914 and in 1920 it was decided that still more commodious premises were necessary. Accordingly a large area of land was acquired some three miles from Dehra Dun and it was developed first by the construction of Workshops for the Economic Branch. This Branch had for years felt the difficulty of carrying on at the old buildings and now has new and spacious accommodation. A large hall contains nearly a dozen testing machines where all the important timbers of India and Burma are being subjected to elaborate scientific tests, in charge of an expert from Canada. Wood preservation also has its own section and experimental pressure-treating plant where much useful work, especially on the preservation of railway sleepers, has been done. Five fully equipped up-to-date drying kilns are in operation, three Tiemann and two Sturtevant, where much useful experimental work on the seasoning of Indian timbers has been carried out. In the wood workshops Indian carpenters are trained and Indian woods are tried for all purposes, veneers, panelling, furniture, etc. In the paper-pulp section, which is fully equipped with digesters and a paper machine, experimental work is continually carried on especially with the important Indian bamboos, and excellent pulp and paper have been turned out and bleaching costs reduced.

Laboratories and offices have been built and are occupied by clerks, computers, and technical assistants of many grades, and the workshops have their own boiler and mechanical staff.

A large Institute is being constructed on the same estate to accommodate the other Branches and the President, and it is proposed to build bungalows for all the officers of the Research Institute as well as for the subordinates and clerks, so that there is every likelihood of the Institute developing into a small town in a few years.

The Silvicultural Section has made great strides during the past few years especially as regards the collection and tabulation of statistics, which have been got together not only by the Silviculturist at Dehra Dun but also by local officers.

The Entomological Branch has developed into a very important department, where the study of the forest insects of India has proceeded on far-reaching lines and the investigations are acquiring international repute.

In Botany and Chemistry the advance has been slower, but many useful investigations has been carried on in these Branches also.

In the Provinces the advance in Research has been steady; all the important Provinces have realised that they must have their own officers. The United Provinces, Central Provinces Burma, Bengal, and Bihar and Orissa have their own Silviculturists, who have within the last few years made tremendous strides in introducing more scientific methods of growing crops of trees, and in making Divisional Officers realise that there is more in running a forest division than merely office and office work. On the utilization side even more has been done. Experts from the United States of America are employed in one or two Provinces in connection with the extraction of timber on a large scale and Utilisation Conservators have been appointed in the United Provinces, Punjab, Bombay and Burma. These officers have in their own hands the chance to alter entirely for the better the methods of marketing Government forest produce. Matters are not always easy, because firms with large vested interests have a good deal to say, but it may be stated that the old haphazard methods of marketing have largely disappeared and with properly managed depôts, arrangements for seasoning, etc., the timber from the

forests gets a much better chance of being put on the market in good form.

Every Province is realising the advantages of Research in all branches of forestry, and when finances permit, we may expect to see a great development of forest research in all Provinces of the Empire of India.

A. R.

THE PROGRESS OF SILVICULTURAL WORK IN BURMA.

EARLY MEASURES UP TO 1856.

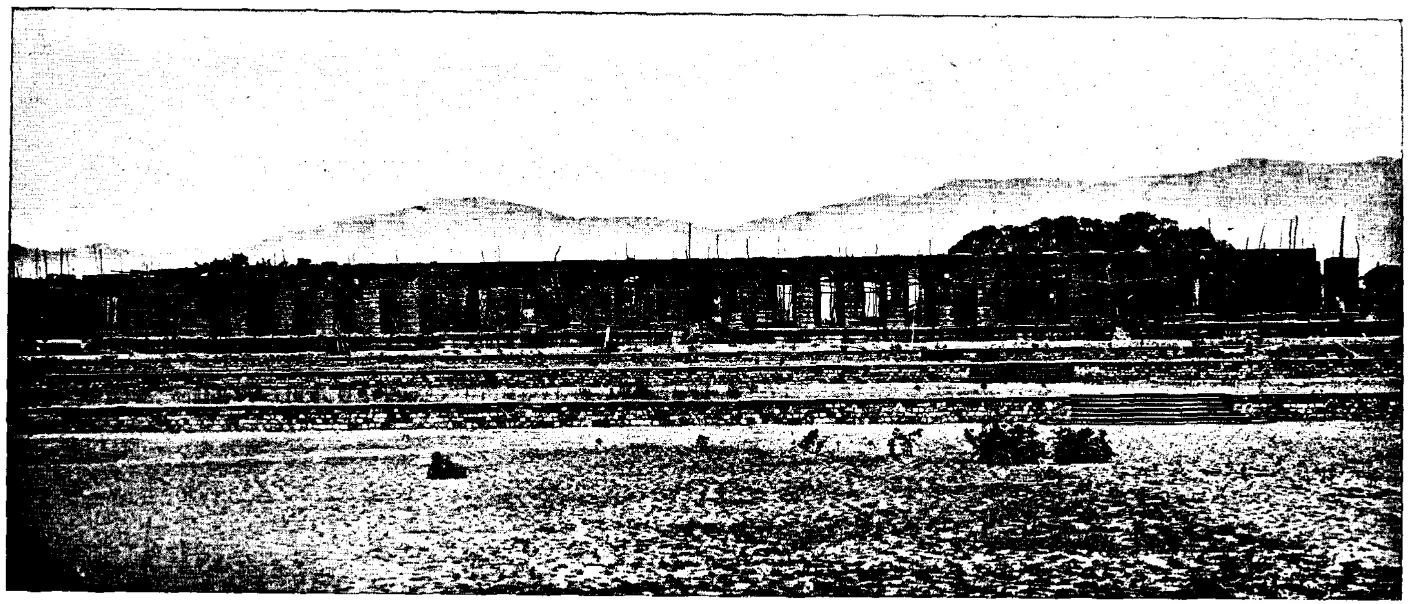
Soon after the Tenasserim Province was first annexed in 1826 the Province was visited by Dr. Wallich, who recommended the commencement of teak plantations. Little seems to have been done though a forest staff of "one head man and eight to ten coolies" was sanctioned for the purpose of planting and rearing teak seedlings in addition to looking after the work of the timber-cutters. Rules drafted in 1841 laid down that "for every tree felled and removed five young trees of a proper size shall be planted by the license-holder or by Government at the expense of the former." Finding that no steps were taken to carry out these rules in 1843 Captain Tremenheere, the first Forest Officer ever appointed in Burma, formed four Government nurseries or plantations, but these were all failures. In the meantime, Wallich who visited the forests again in 1841, Helfer somewhat earlier in 1838-39, and Falconer, who visited the forests in 1849, all drew attention to the great damage done by fire and noted especially on the absence of regeneration which they consider mainly due to this cause.

PERIOD, 1856—1880.

Regular plantations.

The first actual attempts at artificial regeneration of which traces still remain were small plantations made in 1856 at Thingannyinaung in what is now Ataran Forest Division, and at Shwegun in the Salween Forest Division. This was followed by the Prome plantation which was commenced in 1857. In 1862 Brandis started the Myodwin plantations in Zigôn Forest Division to give employment to the permanent labour force during the rains, and operations were extended to the Brandis plantation near Kangyi in 1864 and to the Bawbin-chaungwa in 1865; both these areas being in the Zigôn Forest Division. Operations were commenced in the present Tharrawaddy Forest Division

THE FOREST RESEARCH INSTITUTE, DEHRA DUN
NEW SITE (KAULAGARH).



South Front of one wing of the Main Institute Building now being constructed.
Photographed May 25th 1925.

at Kywemakaing in 1866 and in Insein Division at Kyetpyugan in 1876, though in the latter case as well as in some of the other areas agricultural crops were taken off the areas in the year of formation.

On the Sittang side plantations were made as early as 1862, though surviving plantations were formed somewhat later than this, about 1868, at Pyonchaung and in the Kabaung. In Major Seaton's first annual report for 1867-68 he gave the total area of plantations as follows :—

Division.	*Area.*
	Acres.
Rangoon	45
Tharrawaddy...	351
Prome	66
Sittang	285
Salween	17
Total	764

In most of these areas the forest had been cut and burnt and teak seed dibbled at various spacings. A good deal of transplanting had also been done though, on the whole, direct sowing appears to have been found most suitable.

Seaton laid down the lines for future work as follows :—

(1) Plantations to be confined to areas where growth of teak was good, where extraction was easy and where work could be extended year after year until a more or less compact block of plantations was formed.

(2) Cereals and other crops to be raised with teak to reduce expenditure.

(3) The area required for each block should be acquired after survey and mapping, made into a Forest Reserve and fire-protected.

During the period 1870 to 1880 regular plantations gradually declined and gave place to *taungya* plantations which were proved to be very much less expensive and easier to form.

Sample plots taken recently in some of the earlier regular plantations give the following results :—

Division.	Name.	Year of formation	Age.	Average height of dominant stems.	Average diameter of all stems.	Vol of timber over 8″ in diameter. Tons of 50 c.ft.	No. of stems per acre.
1	2	3	4	5	6	7	8
Zigôn ...	Brandis plantation, Kangyi.	1864	60	105	16·4	51·3	65
N. Toungoo ...	Pyonchaung	1868	55	108	15·5	52·5	58
Ataran ...	Thingannyinaung	1856	68	141	22·5	144·2	61
Zigôn ...	Myodwin ...	1864	60	123	20·5	99·6	52
,, ...	,, ...	1863	61	119	17·2	77·9	66
,, ...	,, ...	1862	62	118	16·8	74·5	65

Taungya plantations

Brandis first suggested the use of *taungya*-cutters for the formation of teak plantations in 1856. Very little seems to have been done until 1862 when it is reported that teak seeds were supplied to *taungya*-cutters in Toungoo, and the first *taungya* teak plantation was apparently made by U San Dun, a Burmese forester in this Division. Considerable progress appears to have been made between 1863 and 1866 by Graham who was then in charge of the Toungoo Forest Division. It is, however, doubtful if much of these early efforts are now traceable. On the Tharrawaddy side teak seeds were given to Karens in 1863-64 and a special officer was deputed to explain the idea to the Karens. He was not very hopeful of success until a strict application of the Forest rules should compel the Karens to compound for destruction of teak and other breaches of the rules by planting teak in their *taungyas*.

By 1872-73 only 99 acres had been established by this method. From that time on the area steadily increased partly because the *taungya*-cutters had got accustomed to the idea and appreciated the employment and money the work brought to them, and partly through the efforts of Seaton who induced the Karens of Tharrawaddy and Prome to plant by the promise of definite *taungya* areas in the reserves then being formed. The total area planted by this method up to 1879-80 amounted to 2,500 acres. When *taungya* plantations were first started the formation of densely stocked plantations does not seem to have been the primary object. All it was hoped was that there would be sufficient stocking of young teak trees to carry on without much tending and give an increased yield at maturity. It was only later that closely stocked plantations requiring tending were formed, and this accounts for the fact that, in spite of large areas being planted in the late sixties and seventies of the last century, it is now almost impossible to find sufficiently well-stocked areas to give sample plots for these years.

Fire-protection.

It is not quite certain when fire-protection was first instituted but mention is first made of it in the 1872-73 report which showed that some fire-protection at least was commenced in 1869. In 1872-73 the following areas were successfully fire-protected :—

Tharrawaddy	Division	...	Mokka Bilin.
Zigôn	,,	.	Bawbin-chaungwa.
Salween	,,	...	Sinswe reserve.

Kangyi reserve in the present Zigôn Forest Division and the Muchaung and Wamuchaung reserves in Salween Division were attempted but unsuccessfully. The total area protected was 57 sq. miles. Increased fire-protection dates from Ribbentrop's arrival in Burma. Throughout his service, he was a staunch believer in wholesale fire-protection. In his first annual report, 1874-75, he noted on the inadequacy of measures taken for fire-protection, and showed that there was only one reserve in which fire-protection had been successful during the past three years. The area protected in this year amounted to 71 sq. miles and the cost

to Rs. 4,267. Gradually as new reserves were taken up and larger areas were planted the area under fire-protection increased, until by 1880-81 fire-protection was attempted over 150 sq. miles of which 120 sq. miles were successfully protected at a cost of Rs. 10,577.

The first doubt of the efficacy of wholesale fire-protection is mentioned in a report by Slym in 1876-77. He reported that prolonged fire-protection in the Sinzwe reserve had done harm to the natural regeneration of teak. In 1877-78 Ribbentrop said that the time had arrived when it was already possible to notice the beneficial influence of continuous fire-protection.

PERIOD, 1880 TO 1900.

Progress of taungya plantations.

Areas planted up by *taungya* plantations annually increased rapidly from 1,000 acres in 1880-81 to 4,100 acres in 1897-98. It was probably about the time when the plantations began to increase more rapidly that the idea of forming fully stocked and tended plantations gained strength. Certainly the plantations formed about 1880 and later show a stocking which few, if any, of the *taungya* plantations made before that date show. From about 1897-98 some slight falling off in the area of *taungya* plantations made annually is noticeable. This was due to the unsystematic manner in which plantations had been scattered all over the forest, and the increased attention necessary to thin and tend these scattered plantations. How this difficulty led to the almost complete cessation of *taungya* plantations will be shown in dealing with the period 1900 to 1925.

Improvement fellings and other works.

Very little in the way of improvement fellings seems to have been done before 1900 with the exception of climber-cutting and the felling of trees enveloped by epiphytic *Ficus*. These operations were usually carried out in connection with girdling. Towards the close of the period, with the growth of opinion against *taungya* plantations owing to the unsystematic method in which they had been carried out, more attention was directed to im-

provement fellings and cultural operations. Among the latter, dibbling of teak seed in the natural forest was carried out to some extent, though with very indifferent or entirely negative results.

Fire-protection.

The area brought under fire-protection was increased rapidly amounting to 296 sq. miles attempted in 1885-86 of which 238 sq. miles were successfully protected at a cost of Rs. 14,377. The following quinquennial figures show the further rapid increase of protection.

Year	Sq. miles attempted.	Sq. miles protected	Cost.
Lower Burma only.			Rs.
1890-91 ...	447	368	23,677

Upper Burma was annexed in 1885 but no fire-protection was commenced until 1892 with the exception of small areas of plantations near Mogok. Fire-protection was commenced in this year in the Yanaungmyin reserve, Pyinmana Forest Division.

Year.	Sq. miles attempted.	Sq miles protected.	Cost.
Lower and Upper Burma.			Rs
1895-96 ...	1,307	1,178	47,957
1900-01 ...	5,164	4,562	1,53,733

Up to 1894-95 all Forest officers appear to have accepted the necessity of general fire-protection without argument. In this year, however, Slade, then Divisional Forest Officer, Tharrawaddy Division, summarised the advantages and disadvantages of fire-protection and concluded as follows :—

> "Fire-protection would therefore appear detrimental to the natural regeneration of teak, if carried out strictly year after year, but not so for many other trees. In plantations or wherever seedlings of any species are established fire-protection is absolutely necessary."......

This caused considerable discussion which was summarised in the Local Government's resolution on the report for 1895-96......

"Opinions vary, but it seems generally agreed that though reproduction of teak is better in unprotected than in protected areas, yet that, on the other hand, fires do immense damage to mature and growing teak and that the damage to young teak growth resulting form fire cannot be prevented by other means than fire-protection, while any unfavourable effects of fire-protection can be remedied by other means, namely, improvement fellings."

At the same time this difference of opinion did nothing to stop the rapid increase of area under fire-protection, and in the resolution on the annual report for 1896-97 the Lieutenant-Governor expressed the opinion that .... "The utility of fire-protection is undoubted and it should be pushed forward as rapidly as possible." This opinion was strongly endorsed by Ribbentrop, then Inspector-General of Forests, who recommended in 1897 that fire-protection should be extended as far as funds and administrative considerations allowed. The controversy over fire-protection continued for many years as will be described under the next period, but during the earlier part of the controversy little attention appears to have been paid to what was eventually realised as the crucial point—the financial justification of the work.

PERIOD, 1900 TO 1925.

Situation at commencement of period.

In 1901 *taungya* teak plantations were being carried on with but slightly diminished ardour. At the close of the forest year 1900-01 the total area of plantations was as follows :—

(1) *Taungya*—

(*i*) Teak	..	47,000 acres.
(*ii*) Cutch and others,		4,758 "
(*iii*) Teak and cutch,		6,299 "

(2) *Regular plantations*—

(*i*) Teak	...	3,482 "
(*ii*) Cutch	...	52 "

Note.—These figures are approximate only as the actual area is not given in the annual report until 1904-05.

Improvement fellings and other measures of improvement such as climber-cutting and cultural operations were only carried out over small areas. Only 217 acres of cultural operations are recorded for the year 1900-01.

Progress during the period.

Plantations—Although the popularity of *taungya* plantations was on the wane very large areas were planted up in the first few years of the period, amounting to 2,288 acres of teak and 1,239 acres of cutch in 1903-04. At the same time more attention was being paid to cultural operations such as dibbling of teak in blank areas, and in 1903-04 no less than 6,706 acres were worked over by cultural operations. These were chiefly in the Southern Circle. At the same time the large areas of plantations gave rise to complaints of the difficulty of tending so many scattered areas. This difficuity appears to have been voiced in the first place by the late Mr. J. H. Lace in his annual report for the Pegu Circle in 1904-05 as follows :—

> " The upkeep in an efficient manner of the enormous area of plantations in the Pegu Cirle would be a heavy task even if the plantations were more or less concentrated and it is therefore not surprising that it is quite beyond the capabilities of the staff to control and carry out the frequent operations that each plantation requires to help it to reach maturity, when the plantations are scattered all over the forests, as happens to be the case, and hundreds of them are an acre or less in extent. The present difficulty seems to have been brought about by the absence for many years past of any method in selecting areas for *taungya* plantations, by want of concentration of the work, and by the selection of areas having had to be left to a great extent to the subordinate establishment, which means in many cases that the *ya*-cutters have selected their own areas. The last fact has also led to the making of *taungya* plantations in forest already rich in teak and cutch, many instances of which have already been seen by the writer. The cost of main-

> tenance and execution of necessary works must obviously be inversely proportional to the size of the plantations, which is a very material reason why small scattered plantations of two or three acres each should not be made, and the Conservator during a prolonged tour endeavoured to impress upon Divisional Officers the necessity for making the *taungya*-cutters of one or more villages concentrate their work in contiguous areas."

At the same time opinion was strengthening in favour of more assistance being given to the natural forest by improvement felling and cultural operations. Matters culminated in 1906 when the Local Government issued instructions for the future conduct of planting operations. Commenting on the annual administration report for 1904-05 the Government of India had drawn the attention of the Local Government to the desirability of laying down more definite lines for the extension of *taungya* operations, and the instructions of the Local Government were drawn up in accordance with this note. Briefly the instructions of the Local Government laid down that teak *taungya* plantations should not in future be undertaken except—

(1) In teak bearing areas where natural reproduction was not existent and could not be induced. In such localities blocks were not to be less than 25 acres in extent.

(2) In areas where it is decided to encourage the presence of villages in order to provide labour for forest operations. In such cases plantations should be as concentrated as possible and should not be permitted in areas already holding teak. Cutch *taungyas* were to be discontinued altogether except where they might be necessary to keep the jungle people contented.

The Local Government further desired that extensions to plantation work should be limited to 25 acres in Lower Burma and 100 acres in Upper Burma, in any one Division in view of the desirability of concentrating the efforts of the staff on the improvement of the natural forests by improvement fellings and on their fuller exploitation. These orders were issued in April 1907 and resulted in a very considerable decrease in the areas

planted up every year as may be shown by the following statement :—

	30th June 1907.	30th June 1918.
Regular plantations ...	3,737	3,354
Taungya plantations—		
(*i*) Teak	58,601	62,797
(*ii*) Cutch and others ...	8,868	8,336
(*iii*) Teak and cutch ...	5,484	6,013
Total *taungya* plantations ...	72,953	77,146

NOTE:—In case where figures for 1918 are less than those for 1907, areas had been written off as unsuccessful.

Improvement fellings.—Following the reduction of plantation work considerable attention was paid to improvement fellings and inducement of natural reproduction. Cultural operations such as dibbling of teak seed were also carried out on a large scale, but were generally a complete failure. The use of fire in encouraging natural regeneration of teak was studied and there was a very heated controversy on the benefits of fire-protection with regard to its effect on natural regeneration of teak. This subject will be referred to briefly under the head of Fire Protection. For the next few years after the issue of the Local Government's instructions curtailing *taungya* plantations, improvement fellings came very much to the fore and large areas were worked over by this operation though a good deal of it appears to have been of the very lightest description in many divisions as shown by the following figures for the whole Province :—

1907-08 ... 90,009 acres, cost Rs. 28,256 or 5 annas per acre.

1908-09 ... 78,195 acres, cost Rs. 36,028 or 7 annas per acre.

Work continued on this scale for several years.

During these years Forest Officers realised that under the Selection system improvement fellings should be divided into

two classes, the one class designed to help the larger trees of the more valuable species (these were later called "O" fellings) and the other class designed to assist natural reproduction of the valuable species and if possible to induce further natural regeneration (these were later called "Y" fellings). Considerable work was being done more especially on the second class of these fellings when the first Burma Forest Conference met in 1910. There was a heated discussion between the advocates of a more uniform system of working and those who still favoured the Selection system. The discussion centred mainly on the question of the extent to which improvement fellings could be carried out. The majority favoured the Selection system provided improvement fellings could be carried out adequately to protect and increase the younger age-classes of the more valuable species. It was finally agreed that fellings of the "Y" type had to be concentrated and repeated until their object was attained. For several years improvement fellings more especially of the "Y" class were carried out over considerable areas (93,143 acres costing Rs. 55,409 or about 10 annas per acre in 1913-14 and 134,047 acres costing Rs. 78,928 or 11 annas per acre in 1914-15) and with increasing intensity culminating in what amounted to a regeneration felling made by Mr. H. L. R. Walsh in the Saing Yane forests of the North Toungoo Forest Division in 1916. Here the felling consisted of a complete removal of all trees except seed-bearers of teak and *pyinkado* and a clear-felling of all bamboos and undergrowth followed by as complete a burning as possible. Natural regeneration was on the whole good, but rather uneven and depended naturally on the proximity of the seed-bearers. The cost approximated was even slightly higher than the cost of a good *taungya* plantation although the stocking under this method of regeneration could not compare with a fully stocked plantation.

Previous to taking over charge of the North Toungoo Division, Mr. Walsh had been in charge of the Tharrawaddy Division and had there commenced a series of heavy improvement fellings in favour of young *pyinkado* regeneration. *Pyinkado* regeneration was found to be very plentiful in a type of lower mixed forest

known as *thitkyin* which was characterised by the absence of bamboos. These improvement fellings commenced in 1910-11 and work continued for several years with a view to establishing the natural regeneration of *pyinkado*. By 1917 this had been attained over considerable areas, but the results were somewhat uneven and could not compare either in cost or results with a good *taungya* plantation.

With the advent of the clear felling system with artificial regeneration with *taungyas*, "Y" improvement fellings as a class have ceased to exist. In the meantime little progress was made with the other class of improvement fellings. A certain amount of work was carried out in some divisions but this usually, with the exception of those carried out in the Upper Chindwin, consisted of the sacrifice of trees of all species in the interest of teak. This in accessible areas where the timber was exploitable could not be justified. In the Upper Chindwin division, however, improvement fellings combining the two classes of "O" and "Y" fellings have for many years been carried out with considerable success, but the forests in this division are so inaccessible to the extraction of any timber other than teak that the extermination of other species in the interests of teak is entirely justifiable. With the advent of the clear felling system the class of fellings previously called "O" have assumed considerable importance. In areas worked under the clear felling system these fellings are increasingly important in areas which will not be regenerated until towards the end of the rotation. Moreover, under the present policy all less accessible forests will continue to be worked under the Selection system, and improvement fellings are essential after extraction of teak in order to maintain or increase the proportion of teak in the forest. It naturally follows that where one species in a mixed forest is being exploited it is essential to cut out an equal proportion of the other species in order to maintain the relative density of the species which is being exploited. The present policy therefore is to carry out improvement fellings following the extraction of teak in Selection working circles and of all species in areas in the concentrated regeneration working

circle which do not fall in the regeneration block and have been worked by selection. The class of improvement fellings now being carried out in the selection forests is a combination of the old "O" and "Y" fellings. Apart from climber-cutting which is carried out over the whole area, if possible, improvement fellings are concentrated on the more valuable teak producing forests and consist in a removal of mature trees of the less valuable species on at least a similar scale to the removal of teak and the more valuable species by extraction, the thinning and cleaning in the older age classes and a concentration of bamboo cutting and clearing over groups of reproduction and saplings.

H. R. B.

(To be continued.)

FORESTRY IN THE CENTRAL PROVINCES AND BERAR.

To convey an adequate idea of the development of forestry in the C. P. and Berar during the last 50 years it is necessary to go one decade beyond the founding of the *Indian Forester*, because the achievements of the Forest Department can be properly judged only by contrasting the pioneer labours of Sir Richard Temple and his fellow-workers with what we see now. When Sir Richard was appointed Chief Commissioner of the newly constituted Central Provinces in 1862, the Saugor and Nerbudda territories had been under British administration for 44 years and the Nagpur country for eight. Berar had been assigned to the British in 1853, and though it was only to come under the administration of the Chief Commissioner in 1903 still the first C. P. Conservator was soon called in to advise about forest administration there. The task of giving effect to the then new idea of forest conservancy was only one of the many great problems which the Chief Commissioner had to tackle. The difficulty of communication in those days can be judged by the fact that there was no metalled road in the Province, the machinery of Government was primitive and rights in land were undetermined.

Sir Richard was the last man to be daunted by the magnitude of the task confronting him. The development of communications, the building up of a general administration approximating to that existing in the older Provinces, and the settlement of the land were all intimately connected with and reacted on the beginnings of forestry. A vigorous programme of road construction was initiated, a staff of officers of unusual brilliancy, many of whom afterwards became heads of provinces, was collected together and revenue settlement operations were set in motion througout the country. The Chief Commissioner's endurance as a horseman, of which traditions still linger in the province, enabled him to visit every part of his new charge, despite the absence of completed roads, and his administration reports in which he describes his journeys and activities are

among the most interesting of official literature in this country. With the help of Sir D. Brandis, he set about formulating a forest policy and forming the nucleus of a forest service from among the officers already in employ, mostly soldiers, who showed a natural aptitude for the work. Among them stand out the names of Captain, afterwards Colonel Pearson, Inspector-General of Forests, who was appointed the first Conservator and who in the Bori teak forests of the Hoshangabad division cut under the guidance of Brandis the first fire-line in India, and Captain Forsyth, the author of "The Highlands of Central India," the materials for which he gathered mostly during his tours in the task of examining the forests and recommending areas for conservation. That there should have been only one Conservator for the huge area of the C. P. is a striking illustration of the conception then prevailing of the scope of forestry and of the embryonic state of the administrative machine. Captain Pearson's activities were scattered over not only the present 18 revenue districts with an area of 82,000 square miles, but also Sambalpur now transferred to Bihar and Orissa and the large areas which were shortly to become feudatory states. As if this task was not enough, he was also sent, as mentioned above, to examine the forests of Berar and advise on their administration, though 40 years were to elapse before Berar came under the Chief Commissioner's control. Captain Pearson and his Assistants correctly talk of their reports as records of exploration, for their journeys took them into the parts of the country inhabited by some of the most backward tribes of India which had scarcely ever been visited by an European and never examined by the eye of a forester.

The constitution of reserved forests had to go hand in hand with the determination of rights in land. Definite rights, as we know them now, were non-existent, and in evolving order out of chaos and legal rights out of customary tenures, it was unfortunate, from the purely forest point of view, that very sound and adequate political and administrative reasons compelled the Chief Commissioner to place large areas of good or potentially good forest beyond the possibility of being included

in the Government reserves. In the more remote parts there were large estates of a quasi-feudal kind held by ancient families whose degree of submission to the central power for the time being varied with the vigour of that power. The more important of these tracts the Chief Commissioner decided should be constituted as feudatory states and the lesser ones as *zamindaris*, a term which in local parlance has more than its literal meaning of the property of a landlord and connoted the delegation to the owner of some of the functions of the Government. Though there could be no reserved forest in these areas, the early administrators cherished the hope that their owners might be induced to accept the principles of conservation or even lease the more valuable portions to the Forest Department for management, a hope which is only now beginning to be realised. But even in the parts of the country which were to come under ordinary administration the hands of the Government were not free to establish as reserves those areas best suited for the purpose. The orders of the Supreme Government conferring proprietary rights in land expressly contemplated the exclusion from the grant of all areas over which no effective possession could be proved and directed that the grant should include only such adjoining uncultivated land as was necessary for the user of the village communities and for expansion of cultivation. But even with this limitation there was inevitable difficulty and delay in settling the areas in which the rights of the Government should be reserved. Occupation in the old days had followed its own sweet will, as it does to-day to a large extent in the *zamindaris*. Cultivation instead of being concentrated was scattered all over the country, wherever an energetic man might establish a village, and a radical attempt to concentrate cultivation in the interests of the forests was impossible, and in a country where survey was just beginning, the examination and demarcation of what should be private land and what Government reserve was naturally a lengthy and tedious process. The early forest reports are full of references to the delays in establishing reserves due to the revenue officers not having been able to advance far enough in the task of demarcation. It is very easy now to criticise the manner in

which the demarcation was in the end done in some parts of the country, and many initial mistakes have been rectified by exchange with private owners, but when one considers the magnitude of the work and the legitimate desire of the Chief Commissioner to push it on so as to hasten the establishment of a regular and ordered administration, one should rather be thankful that mistakes were not more numerous than regret that they did occur.

The state of the forests can best be judged from Sir Richard Temple's description of the ravages which had been caused by many generations of shifting cultivation locally known as *bewar, dahia, jalapod* or *khamori*. He says:—

> "One great cause of wastage and destruction of the forests is what is called *dhya* cultivation. Much was said and written on this peculiar cultivation, and some have supposed that it ought to be stopped altogether. It may, therefore, be desirable that I should explain the matter. This *dhya* cultivation is practically a substitute for ploughing, and a device for saving the trouble of that operation. It is resorted to by hill people, who are averse to labour, and have little or no agricultural capital. The method is in this wise:—A piece of ground on a moderate slope is selected, clothed with trees, brushwood and grass, the trees are cut down in November, the brushwood and grass are set fire to in May, the charred ground is left covered with ashes; in the beginning of June quantities of seed are placed at the upper end of the slope, the rains descending wash the seed over and into the prepared ground. No ploughing or any other operation is resorted to. There springs up a plentiful crop, which has to be watched all day and night till it is cut. If not so watched, it would be eaten up by wild animals. In this manner all the pulses are raised. Beside this culture, there will be a few fields around the homesteads regularly ploughed and growing superior products. The pulses, however, form the staple food of the hill people in four districts (Mandla, Seoni, Chhind-

wara and Betul), and in many parts of districts adjacent to them. The population dependent mainly on *dhya* cultivation is between one and two millions. Now, it is unfortunate that the best ground for this peculiar cultivation is precisely that where the finest timber trees like to grow. The damage thus done during ages is incalculable; but to stop this cultivation now would be a serious, indeed a lamentable undertaking. It may be hoped that, by degrees, these hill people will learn a better mode of cultivation. But to prohibit the *dhya* cultivation altogether would be to drive this widely scattered population to despair. Though rude and ignorant, they are not destitute of spirit and endurance; they have clans and chiefs; they are always predatory; and they have, on occasions, shown themselves capable of armed resistance. If, by a prohibition of their favourite culture, they were reduced to any distress, they would resort to plunder, and especially to cattle stealing. And it is to be remembered that the great pasturage, whither the cattle from the plain-districts resort, is situated in their country. Perhaps even they might resort to a sort of rebellion. And if they fled the country, the last state of the forests would be worse than the first. For then the trace of human habitation, settlement and clearance would disappear. The foresters and the woodmen could no longer live in or even enter into the wilderness, rank and malarious, with uncleared jungle, and overrun with wild beasts. These animals were already so destructive as to constitute a real difficulty. The only check upon their becoming masters of the forests is the presence of the hill tribes. Inasmuch then, as the entire prohibition of *dhya* is out of the question, the problem is how to check its extension without distressing the hill people. It is possible to keep the culture within certain limits, to prevent new ground being taken up by it, and to restrict it to those spots where

> it has previously existed. In this manner further damage can be prevented. And it is to this object alone that our present efforts are directed."

Apart from shifting cultivation however there was another impediment to reservation. The people who had used and maltreated the forests from the beginning of time regarded any restriction of their license as a curtailment of their liberty, and we early find Sir Richard Temple addressing his Commissioners on the necessity of endeavouring to lessen the unpopularity of the Forest Department, a task with which, however unfair the allegations may be, the Revenue Officer is not unfamiliar up to the present day.

To the state of ruin which Sir Richard Temple depicts was added the great misfortune of the coming of the railway just at a time when forestry was first beginning to receive attention. One cannot but wish that the lines through the province to Jubbulpore and Nagpur had been constructed in the seventies and not in the sixties, because ten years delay and ten years of reservation would have made it possible to avert the great wasteful destruction of the timber and social demoralisation which actually did occur. All the writings of the early forest officers are dominated by the urgent demand for sleepers, which had arisen even before they got to work, and forests which required years of nursing called upon to satisfy a demand far beyond their capacity. Contractors with no thought but to supply their quota of sleepers on the line undertook contracts which were either quite impossible to fulfil or could be fulfilled only at the cost of the utter devastation of the forests, and the more unscrupulous among them did not hesitate to demoralise the aboriginal tribes by paying for the sleepers produced by them in drink. Even now one finds liquor-sellers in possession as landlords in out-of-the-way places who are a relic of those bad old days. The forest officers themselves had to turn their energies to exploitation, when they knew that what was required was conservation, but even if the operations had been carried on with an idea of doing as little damage to the forests as possible, the economical supply of timber was impossible. The lack of com-

munications caused much timber to rot in the jungles where it was felled, much was damaged or destroyed by forest fires which raged all over the country every year in the dry season, and much waste arose from pure lack of skill in cutting up trees. We find the Consulting Railway Engineer complaining that he could not reckon on more than 75,000 sleepers out of 30,000 trees already cut for one section of the line and adding that very few trees left standing in the area were fit for conversion, and the event showed that his estimate was much too optimistic.

Sir Richard Temple early called to his aid Sir Dietrich Brandis, who had already visited the north of the Province when it was still administered by the Government of the North-Western Provinces, and in the latter's reports and the connected correspondence we get a vivid picture of the beginnings of forest conservancy. It was intended to establish what we would now consider relatively small areas as reserved forest for the production of good timber, the remaining land excluded from the grant of proprietary rights being left under the control of the district officers, with the help of subordinates trained in the Forest Department, either for allocation for cultivation as need arose or for administration as forest under simple rules and restrictions for the user of the villages. This decision was partly governed by the ideas of forestry then prevailing but chiefly by financial considerations. Thus Brandis recommended 1,700 square miles for reservation in Chhindwara, Seoni and Mandla districts but added,

> "This is a very large area and it is evident that at once to put the whole extent on the footing of reserve forests would be ruinously expensive. Here also we must proceed with caution."

Yet nowadays the area of reserved forests in these districts exceeds twice that which Brandis hoped would be attained in time. For all his progressive ideas Sir Richard Temple recommended only six forest divisions in the whole of the C. P., all under the charge of the Conservator, and Captain Forsyth, when officiating as Conservator for Captain Pearson in 1866, reconciled himself to the idea of the Forest Department running at a loss

for years to come. These facts are quoted to illustrate the long and laborious task of building up a forest administration in what had hitherto been an utterly neglected part of the country. The early figures of income and expenditure are significant. We find both sides of the account balancing round Rs. 60,000.

In contrasting these early days with the present time one's admiration for what has been achieved is tempered by a consciousness, which every forest officer feels, of what remains to be done. In the C. P. and Berar Government forests now cover 19,500 square miles, including such areas as the "C" class pasture reserves of Berar, and last year in the 8,500 square miles which are fire-protected complete success reached 92 per cent. *Dahia* has been confined to certain very limited areas, where it is deliberately allowed for the benefit of the most backward of the people. The gross revenue 1923-24 exceeds Rs. 51 lakhs and was 60 per cent above what it was 10 years ago. The expenditure was Rs. 30 lakhs, one-third of which went on conservancy and works and two-thirds on establishment. The single Conservator has been replaced by a Chief Conservator and three Conservators, and there are 18 forest divisions in the C. P. proper and five in Berar. The conception of a forest officer's duties and of his place in the economy of the country has expanded. He is no longer merely a man seeking to preserve and restore what remained of a ruined estate, harassed the while by an unreasonable but irresistible demand for exploitation. Gradually there has been built up a system which endeavours to reconcile the steady improvement of the forests with the satisfaction of present-day demands. The charge of what was once the unreserved forest has passed from the Deputy Commissioner to the Divisional Forest Officer, and the most successful forest officer is the man who most happily combines his pure forestry with a just perception of his position in the general seheme of administration.

The importance of the forest officer's duties outside the sphere of pure forestry is best illustrated by the very vexed problem of grazing. It is appropriate to mention it first, as it is the duty most criticized both by the keen forester and by the critic to whom all control of the forests is anathema. Last year, thanks

to rates which all forest officers and many others regard as a direct temptation to the retention of worthless animals, over three and a third million animals grazed in the forests and brought in a revenue of nearly Rs. $13\frac{1}{2}$ lakhs. It is easy to jeer at the employment of a forestry expert on supervising grazing and collecting grazing dues, but to do so is to misjudge the D. F O's position in the economy of the province. In a tract where the growing of fodder crops is almost unknown except in so far as they are incidental to the production of food for human consumption and where, as the proceedings of the Legislative Council show, the destructive effect of excessive grazing is as yet only dimly comprehended, if at all, prohibition of grazing is a sheer impossibility and its regulation must find an important place in every working plan and consequently in the regular routine of the forest staff. The forest officer has still to combat the popular idea that the forest must provide all the grazing that is demanded of them and must preach what should be the obvious doctrine that grazing demands must adapt themselves to what the forests can stand without deterioration. It is a hard task, but it is a good omen that last year the Provincial Board of Agriculture, with a non-official majority present, endorsed the Government's past policy of having each working plan examined by a revenue and a forest officer in consultation so as to assure the maximum convenience of the people consistent with the preservation of the forests.

Similarly in times of famine and scarcity the forest officer is one of the district officer's chief lieutenants in combating distress. The necessity of finding employment gives him an opportunity of pushing on forest road construction, improvement fellings and creeper cuttings, but such works attract mainly those accustomed to them and his main function is to afford help to the general body of the people living outside the forests. He has to suspend grazing dues, extend temporarily grazing facilities and permit the free extraction of headloads of grass, edible products and fuel. The promptness with which this help is afforded and the succour it gives to man and beast are amply illustrated in the reports of the scarcities following the failure of the monsoons of

1918 and 1920. The Chief Conservator in his last quinquennial reviews quite correctly describes these relaxations of strict forest policy as a tremendous hindrance to progress. They are no doubt, but it is well to bear in mind the other side of the picture.

The third important function of the D. F. O. outside pure forestry is about the most interesting. He is the administrator of the numerous forest villages which have been established within the reserves, primarily to assure a supply of labour in the forests and which in the Hoshangabad division, for example, number 108. But to regard these villages only as a source of labour is to miss the important rôle they play in the advance of the jungle tribes. The D. F. O.'s administration is frankly paternal, and it would be a bad thing if it were anything else. The ordinary revenue law does not apply, but under the simple and understandable rules of administration in force settled cultivation, which means a settled mode of life, has taken the place of *dahia* and the foundations are being laid of economic and social progress. Most interesting of all is the decline of the immemorial drink habit, which especially strikes officers who return after a spell of duty beyond the province. Transient waves of temperance enthusiasm apart, drinking for drunkenness sake, which proved the bane of the aboriginal in the sleeper days is rapidly declining, though the temperance problem is still far from solution.

In pure forestry the Chief Conservator still describes the department as "trying to build up a ruined state." If the word ruined be taken as relative to what might be and not to what was, the description holds, but the best corrective of present-day despondency is a consideration of the early conditions outlined above. Improvement at the sacrifice of possible immediate revenue has been the key note of Sir Henry Farrington's administration and of his predecessors, and their efforts are to be judged not by the present-day extraction of sleepers from the *sal* forests of the east of the province or of the teak of Çhanda, but by the quality of the young stock coming on. Sir Henry closes his quinquennial review with the optimistic note that there is no need to underrate the immense potential value of

the C. P. forests, especially those supporting teak. The Melghat in the north of Berar gives excellent justification of the Chief Conservator's optimism. Teak areas in which in 1877 Sir D. Brandis recommended the abandonment of all attempts at conservancy because they had degenerated too far, were afforested in 1909 and are now showing promise far beyond expectation.

It is easy to complain that progress has not been more rapid, but when a few years ago a local forest officer signing himself "Hark Forrard" urged a more forward policy in the pages of this journal, nobody took his strictures more seriously than he himself intended. He advocated five conservatorships in place of three and 29 territorial charges instead of 23 and a general advance all along the line. No one doubts the soundness of the general lines which he mapped out, but the rate of progress is determined by the rate at which the staff can be built up, communications developed and public opinion educated. Forest divisions that average 850 square miles and go up to about 1,700 are obviously too large, but with the long break in superior recruitment due to the War the first stage towards advance is not the increase of divisions to be held by inexperienced officers but increase in the number of attached officers, either of the All-India service to train on for divisional charges or of the provincial service to staff existing divisions properly. And so right down to forest guards, the necessity is for the gradual development and better training of all grades of the staff. Working plans are admittedly mostly obsolete, but even though the reproach of there being no full-time sylviculturist has now been removed, they must await the greater experience of the junior officers now training on.

With 1,400 miles of new forest road to its credit in the last five years the department can claim not to have been idle in the development of communications, but roads cannot be made faster than the labour available permits nor should they be developed at the expense of neglecting the proper housing of the subordinate staff. The exploitation of minor produce depends not on what the forests can produce but on what the market can absorb and

on the ability of the staff to control the operations, and recent experiences in lac prove the danger of attempting to bite off more than one can chew. In areas outside reserved forest, which Sir Richard Temple hoped to control, limitations of staff have confined the activities of the department to lending from time to time of officers to feudatory states and to helping in the drawing up of simple working plans in *zamindaris* under Court of Wards administration, but recently the best teak areas of the Akiri *zamindari* have been taken by the department on long lease, much to the immediate benefit of the finances of the estate and still more to the future value of the forest. But in these areas and in the reserved forests alike the chief obstacle to rapid progress is public opinion. Just as Sir Richard Temple opposed any attempt to stop shifting cultivation at one step, so the department must not advance too far in front of popular prejudices, but must seek always to progress steadily, guiding opinion to a realisation of all that scientific forestry means to the country but not hurtling too violently against it.

J. F. DYER, I.C.S.,
Settlement Commissioner, Central Provinces.

THE PROGRESS OF FORESTRY IN THE UNITED PROVINCES.

To form a correct estimate of the achievements of the Forest Department of the United Provinces during the period 1875—1925, it is necessary to describe briefly the wanton and thoughtless destruction of forests which passed for forestry during the preceding years. The first half of the nineteenth century witnessed an exploitation of forests on a scale hitherto unprecedented in the history of these provinces. For, even during Moghul times some sort of protection was afforded to forests, though in an indirect manner. The uncertainty of tenure, the inaccessibility of the forests, and the limited demand for forest produce were important factors which exercised an efficient check on the destruction of forests and rendered any organised protection unnecessary; while wild animals, snakes and proverbial demons acted as effective forest guards against the inroads of axe and plough. But during the comparatively peaceful times of the Company Rules, an almost callous destruction of forests took place. With the development of new markets at Patna and Calcutta it became possible to tap profitably areas which had hitherto been protected, not by the laws of the Government but by simple economic laws. The District Officers encouraged enterprising speculators to exploit forests in return for a nominal royalty, and gave away valuable forests to grantees for cultivation. In Gorakhpur alone over half a million acres of forests were given away to grantees (1846), while extensive tracts of forests were sacrificed for the cultivation of tea in Kumaun and Garhwal, and the forests of Rohilkhand and Dehra Dun were ruthlessly cut down in spite of a Supervising Officer (1854). Most of the grantees, however, could not fulfil the condition which made it incumbent upon them to clear-fell their forest grants within a prescribed period. The Government had therefore no option but to resume possession of forest lands and were still seeking to dispose of their forests when the Indian Mutiny (1857) broke out,

THE INCEPTION OF THE FOREST DEPARTMENT.

The increased demand for timber for railway sleepers and other purposes during the aftermath of the Mutiny further accelerated the destruction of forests. Some measure of control was sought to be exercised by the Commissioners of Divisions, who acted ex-officio as Conservators (1860), but the real management was entrusted to Engineers who concerned themselves more with the exploitation than with the conservation of forests. Soon after, the inevitable happened, there was a timber famine, and Government realised that their forests were not inexhaustible. At this crisis Dr. Brandis came like a *deus ex machina* as the first Inspector-General of Forests for India (1864). His influence soon began to be felt and the Forest Department was constituted after the memorable conference of the ex-officio Conservators at Naini Tal (1863). Major Pearson was appointed as the first Conservator of the North-Western Provinces (1868), while in Oudh Mr. Read had been appointed Conservator as early as 1861. The Conservators of Oudh and Central Circle (N.-W.P.) were directly under the Government of India till 1882 when the Forest Department was decentralized and placed under the Local Government.

ORGANIZATION.

During the seventies we find the Department busy in evolving some sort of order out of the chaos that had till then prevailed in the management of forests. By 1875, the Department had assumed control of about 3,700 sq. miles of forest land, and the Conservators of Oudh and Central Circles had laid the foundations of the present organization. A Deputy Conservator was placed in charge of each of the forest divisions of Kumaun, Garhwal, Dehra Dun, Jaunsar, Bhagirathi, and Gorakhpur while the forest areas in Rohilkhand (Bijnor and Bareilly), Jhansi and Lalitpur were left to the supervision of the District Officers concerned. In Oudh Captain E. S. Wood constituted Bahraich Kheri and Gonda as separate divisions. With the amalgamation of Oudh and the N.-W. P. (1877) the divisions of Bareilly (Pilibhit) and Gorakhpur were transferred to the Oudh Circle for adminis-

trative convenience. A couple of years later Jaunsar, Dehra Dun and Saharanpur were constituted as a separate Circle attached to the Dehra Dun School. In 1881, the forests of Banda were placed under Sir J. D. La Touche (later the Lieut.-Governor of the United Provinces). Later, they were included in the Bundelkhand Division along with the District Forests of Jhansi and Lalitpur (1892). In 1905 the School Circle was absorbed in the Central Circle and a new circle (the Western) was formed which included Naini Tal, Garhwal, Ganges (Bhagirathi), Siwalik (Dehra Dun and Saharanpur) and Jaunsar, while the Oudh Circle with Kumaun and Bundelkhand was termed the Eastern Circle. Kumaun, Jaunsar, Ganges and Garhwal were later (1911) known as Haldwani, Chakrata, Lansdowne and Ramnagar, respectively. The Kumaun District forests, which were declared "protected" in 1893 were eventually transferred to the Forest Department. In 1912 Mr. Channer was deputed to take charge of them and his, unqualified success in organising and evolving these neglected forests culminated in the formation of the Kumaun Circle in 1915. With the addition of a third circle it was necessary to co-ordinate the activities of different Circles and with this object in view Mr. (now Sir) Peter Clutterbuck was appointed as the first Chief Conservator of Forests for the United Provinces (1915). Sir Peter Clutterbuck revolutionized the entire Department, and amongst the many changes he introduced may be mentioned the formation of the Utilization Circle (1918); and the Working Plans Circle (1920). During the last 50 years the area of the State controlled forests has been almost doubled (7,487 sq. miles) and represents about 7 per cent. of the total area of these Provinces.

WORKING PLANS.

During the early stages of the development of forests, their exploitation was governed by simple economic laws of supply and demand. That economic considerations were apt to upset the continuity of the forest revenue and endanger the safety of forests, was amply illustrated by the results of the reckless extraction of timber between 1871—76 which was more than fifty times

the amount permissible from sylvical considerations. To provide against the recurrence of such acts forest officers were bound to a scheme of operations first issued by the Conservators concerned in the early eighties. These plans of operations were roughly based on the principle that the material extracted from forests should not exceed the interest on the forest capital. In order to ensure a closer approach to this ideal a Working Plans Division was formed in 1880. The following year Mr. Dansey, completed the first Working Plan of the Patli Dun on the lines laid down by Dr. Brandis himself. By the close of the nineteenth century about 85 per cent. of the area of reserved forests had been brought under regular working plans. In 1884, the Provincial Working Plans Branch was placed under the direct supervision of the Inspector-General of Forests (Dr. Schlich) in spite of the vigorous protests of the Local Government. This exercised a healthy check on Working Plans and also ensured a uniformity of work throughout India. Earlier plans showed a tendency towards over-elaborateness and their recommendations were not strictly adhered to in spite of the fact that all deviations had to be sanctioned by the Local Government on the recommendation of the Imperial Superintendent of Working Plans. The systems of management usually prescribed were either the Selection or the Strip Coppice (Oudh). The credit of introducing the Uniform Method goes to Professor Troup who acted as the Superintendent of Working Plans in 1910, and Mr. Collier completed the first important working plan of Haldwani along these lines in 1914. Of recent years a Working Plans Circle has been formed (1920) in these provinces under the supervision of Mr. Trevor who has for the first time succeeded in subordinating economical considerations to sylvical requirements of forests.

FOREST PRODUCE AND ITS DISPOSAL.

With the initiation of the Forest Department the system of issuing long leases was replaced by departmental exploitation, and the produce was brought to Government Depôts started as early as 1872 under the supervision of District Engineers. In 1875, these depôts were placed under Messrs. Winton and Braid

wood who were to receive 10 per cent. commission on all sales. Minor produce was extracted either on Col. Ramsay's *kham tahsil* or permit system. Later on it was recognised that the department system apart from being uneconomical diverted the attention of forest officers, which might have been more usefully employed in attending to forest problems. Ever since 1883, when the Government of India definitely expressed their policy in favour of encouraging private enterprise, the extraction of forest produce has been carried out by private agency and the departmental working has been restricted only to forest areas situated on difficult country. Of the various other sources of revenue which have been developed during the last 50 years, attention need only be drawn to the Resin Industry which was started as early as 1885 in Jaunsar. French methods of tapping and distillation were adopted with necessary modifications to suit the local conditions, and a small factory was started at the Dehra School in 1890. A few years afterwards the Bhawali Distillery was founded (1897) to deal with the produce from Kumaun. The Bhawali factory was finally shifted to Clutterbuckganj (1918) and has now passed into private hands.

During the Great War the Department was called upon to supply large quantities of grass, timber, and naval stores to the front. A sawmill and a turnery were started and creosoting plants were put up at various places. These small undertakings, which did very well during the War formed the nucleus of a colossal scheme which materialized in 1918, when the Government subsidized large factories, which were set up at Clutterbuckganj for the conversion of forest produce into marketable form. That this concern did not unduely infringe upon the rightful sphere of private enterprize, would be apparent from the ideals which inspired the initiation of this policy, which were to start demonstration factories where industrial application of the results obtained at the Dehra Institute could be tried; to turn out skilled carpenters which was hitherto done by the Bareilly Carpentry School; and to impart indirectly a high tone to the furniture industry. The management of these factories, which was entrusted to a set

of highly paid officers, involved at the outset overhead charges as heavy as they were unavoidable. Launched as it was during the boom in the aftermath of the War, this great venture showed sensational losses during the period of stagnation which followed this boom. Unfortunately the educative value of Clutterbuckganj was not sufficiently recognized for want of propaganda, and the Montford Councils condemned one of the biggest ventures to its premature death. The whole concern has now passed into private hands with the Resin Factory, which was hitherto a Goverment monopoly, while the Government holds a watching brief in virtue of its part ownership.

TRANSPORT.

The earliest methods of transport involved an appalling waste and the expense, incurred in hauling up logs along the hill-sides, dragging, and floating, was so prohibitive that very often the value of timber in situ was nil, and generally its market price merely represented the cost of transport. The Forest Officers, therefore, concerned themselves with the improvement of roads and clearing up of streams to facilitate floating from the early seventies and a steady progress has been made ever since. Road making in Jaunsar and Kumaun was literally an uphill task for the accomplishment of which great credit is due to Mr. Bagshawe. In Jaunsar several timber-slides, fuel-chutes and sledge-roads were built from time to time. Other activities in this direction included the regulation of streams, the building of booms, bridges and bridle-paths and the introduction of wire ropeways and portable tram-lines. Big tramway schemes were contemplated in the early nineties but they could not be materialized for want of technical advice. In 1915, Sir P. H. Clutterbuck obtained the services of a temporary engineer to investigate the possibilities of improving forest communications. Little work was however accomplished by him beyond the preliminary survey of an extensive ropeway scheme for Kumaun with lines from Almora and Naini Tal to the railhead at Kathgodam. In 1921, a permanent Forest Engineer was appointed and

since then large tramway schemes at Dehra, Haldwani and Gorakhpur have been taken in hand. Financial stringency has prevented the Government to adopt Mr. Martin's proposed organization (1922) of a separate Forest Engineering Service, and the progress, therefore, in developing methods of transport on modern lines has been slow.

PLANTING AND AFFORESTATION.

Though the forest plantations along the Jumna Canals were started as early as 1820, it was not till the seventies that the forest department awoke to the necessity of planting up denuded forest areas. Of the many plantations taken in hand during the eighties the Sakhui (Gorakhpur), Kheri, Bhira, Ramgarh and Pathri deserve special mention.

In 1884, Mr. Fisher, the Collector of Etawah, made the first successful attempt at the reboisement of denuded lands and valleys, and in about 20 years the Fisher Forest illustrated the possibility of starting such forests in other districts. The need for agricultural forests was emphasized by Dr. Brandis in 1873, and later by Dr. Voelcker who advocated the necessity of creating fodder and fuel reserves on waste lands with a view to help agriculturist. The *babul* plantation at Kalpi (1904) was another indication that such forests were not only feasible, but would also pay their own way. In 1912, the Government declared its policy in favour of afforestation and Mr. Courthope was deputed to survey the denuded areas in these provinces.

A separate afforestation division was organised in 1915, which has made good progress ever since. Attempts made to encourage private enterprize and to co-operate with the Agricultural Department failed to give satisfactory results and since 1923 the entire afforestation work has been entrusted to the Forest Department. The extension of the work to other districts is now under contemplation.

An experiment was made by Captain Campbell (1877) to introduce *taungya* in the afforestation of blanks and grass-lands of Haldwani, which did not yield satisfactory results. Ever since then erratic attempts have been made, but it was not till 1922 that the Gorakhpur *taungya* was started, and by now about a thousand

acres of blanks have been successfully dealt with. The number of villagers that find employment in forests under this system, the fine agricultural crop which they reap free from all encumbrances, and the ease with which the *sal* seedlings are obtained, bid fair at no distant date to increase the prosperity of the villager and to ensure the rejuvenation of the poorest forest areas.

FOREST RESEARCH.

Attention also came to be directed towards the study of Sylvics and other forest problems. The School Circle which had early formed the nucleus of a set of very able officers took the lead in forest research. Mr. Dansey carried out extensive enumerations and collected other working plan data. A quaint and yet ingenious method was adopted to enumerate trees which consisted in pinning cards of different colours and shapes to every tree to indicate its size and species, while Dr. Brandis used to measure diameters of trees 6 inches above and below a nail driven in every tree. Later, Sir Robert Christian's method of measuring girth at 5 feet above the ground was adopted in the determination of the girth increment of *sal*. During the eighties a number of periodical measurements of the girth of *sal* trees were carried out in the Botanical Gardens, Saharanpur, (Mr. Duthie) and in the public gardens of Lucknow and Bareilly by Captain Wood. Later specimen plots were laid out in forests and the results of measurements formed an interesting feature of the annual reports of the nineties. Experiments were also made to study the influence of thinnings on the growth of *sal* and the Conservator of the School Circle arrived at the conclusion " .....the actual annual production of wood per acre is more on the latter (unthinned) than on the former (thinned)." (*sic*) Other experiments included the determination of the durability of timber; the calculation of fuel stack factors (A. Smythies); the germination of seed in forest gardens; the planting of exotics; and the study of natural regeneration; while Mr. Moir made more ambitious though somewhat unsuccessful attempts to determine the number of finished metre-gauge sleepers to a standing tree.

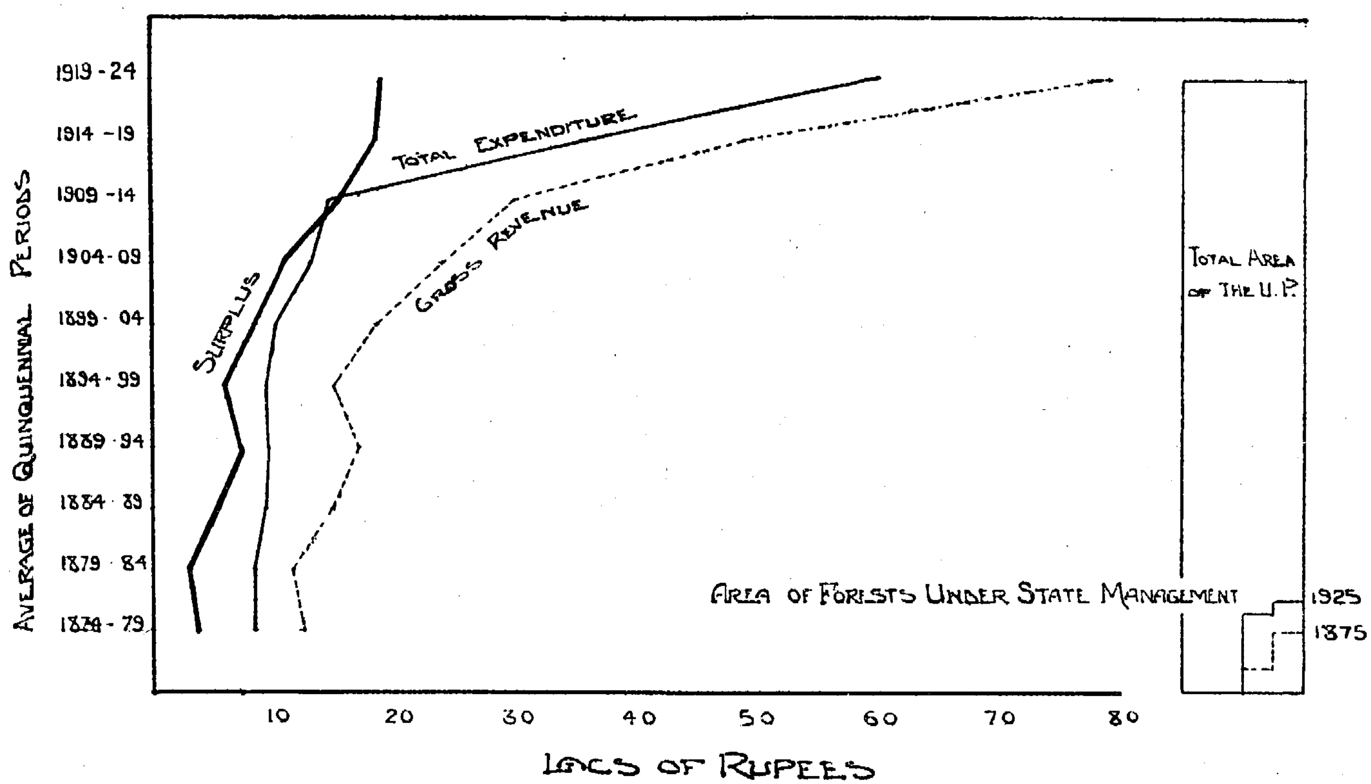


DIAGRAM SHOWING STEADY RISE IN REVENUE AND SURPLUS FROM THE FORESTS OF THE U. P.

Of the later experiments only the investigation of the natural regeneration of *sal* and attempts to plant India-rubber (1902) and the cultivation of lac (1910) and the dry distillation of oak and rhododendron (1917) need be mentioned. In 1918 Sir P. H. Clutterbuck entrusted the sylvical investigations to the newly formed Sylviculture Division.

THE OPPOSITION TO THE FOREST POLICY.

The constitution of Reserved and Protected Forests naturally imposed a limit to the previously unrestricted forest rights of villagers and right-holders. The new order of things was deeply resented and brought the villager into a sharp conflict with the forest officer. The Indian Forester who started his labours in the face of strenuous opposition, not only of the uneducated villager but also of landholders, petty *zamindars* and European grantees had nevertheless, a simpler problem to tackle than his confrére in other countries. Judging from the serious difficulties which other countries had to encounter in constituting State Forests, the surprise is not that there was opposition to the forest policy but rather that there was so little. Prosecutions for forest offences, meant as deterrents only led to incendiarism which was followed by more prosecutions, and the vicious circle was complete. The low paid subordinates played their own part in aggravating the situation. The chief grievance of the Jaunsari, the Gujar and other villagers was about grazing rights, and it must be admitted that the policy of the Department in the early eighties was not altogether above reproach. Things had come to such a pass that a toll was levied on the cattle passing through the forest roads to prevent grazing on the way, and "bullock owners had to take a year's permit even though they grazed for a few days on their sojourn" (*sic*). Matters were however soon mended. In 1884, new grazing rules were introduced and as time passed, the villager got reconciled to the restrictions imposed upon him. The Forest Officers did everything to alleviate the situation by treating the people with tact and kindness. With the formation of the new Kumaun Circle in 1915, the Kumauni behaved precisely in the same manner as did the Jannsari during the eighties. The

formation of "Reserves" led to an epidemic of forest offences which culminated in organized incendiarism in 1921. It would be readily conceded that the Kumauni dependent as he is entirely on forests, had some just grievances the prompt removal of which would have nipped the evil in the bud, but the remedy which has been recently proposed (1923) threatens to jeopardize the very existence of forests which are indispensable to the Kumauni himself. The "Grievance Committee" has only postponed the evil to a date when it might assume alarming proportions.

CONCLUSION.

The steady rise of revenue from forests which is clearly illustrated in the accompanying diagram is an eloquent testimony of the development of forest wealth in these provinces during the period under review. The scientific management of forests has not only averted the timber famine which was threatened in the seventies but has made it possible to ensure an ever increasing supply of forest produce. With the gradual completion of a net work of railways and improved communications areas which were hitherto inaccessible have been profitably tapped; while the cheap cost of transport has re-acted favourably on the price of timber. Various resources which were neglected in the past have been developed by scientific research, and the forests of these provinces which the Forest Department inherited in a ruined state have now been rejuvenated and improved.

M. B. CHATURVEDI, I.F.S.

FORESTS AS A TRANSFERRED SUBJECT.

The recent recommendation of the Reforms Enquiry Commitee that Forests should become a transferred subject leads one to speculate on the wisdom or otherwise of leaving the entire management of practically all our forests in the hands of Provincial Governments.

The most valuable timber producing Government forests should most certainly be regarded as a national and not merely a provincial asset. The maintenance of proper supplies of railway sleepers and of timber required for military or other important public purposes is a matter which concerns the Government of India. Further the maintenance of certain "protection forests" would also be the concern of the Central Government, if their destruction or neglect were to affect interests outside the Province in which they are situated. Until 1912 the Central Government exercised a certain amount of control over the management of all Government forests as working plans had to receive the approval of the Inspecter-General of Forests. In 1912 this measure of control was removed in respect of Provinces with Chief Conservators and in 1921 in respect of other Provinces. As a result Provinces are now permitted to manage their forests on whatever lines they elect whether those lines are in accordance with the national interests or not. Is this wise?

It might be agreed that so long as forest management is carried out on lines determined by the provincial forest experts there is no danger of the national interests suffering. This is not the case however. The work of the Forest Department is generally judged by its revenue results, and the inclination of the Department in each province is to manage its forests on the most profitable lines. In other words it is the financial rotation which is generally adopted. In European countries such as France and Germany, particularly in France, the State policy has been to grow its forests on rotations longer than those which will yield the best financial results, as it is recognised to be the duty of the State to produce larger sized timber than that which the private

forest owner can profitably grow. The reserves of timber thus built up in the State forests of France proved of enormous value in the late war. There has been no obvious tendency in the provinces to regard any of their forests as national assets and to adopt deliberately longer rotations in the general interests of the State. Each province adopts a selfish policy and one cannot blame them for doing so.

Now if this is true of the present forest policies in the Provinces, what about the future when forests generally become a transferred subject ? Can we expect the Local Legislatures to take a longer and more national view ? A study of debates in the Legislative Assembly goes to show how intensively provincial the members of the assembly are in their attitude to national problems. It is hardly therefore thinkable that the members of local Legislative Councils will agree deliberately to sacrifice some of the revenue of their forests in the interests of All India. On the contrary it is far more likely that in the present backward state of Forest education the local Legislative Councils will press for a speedier, and temporarily more profitable exploitation of their forest resources than is advisable. The Forest Department in each Province will have to struggle hard to prevent over-exploitation not to say disforestation. If the present proposal to transfer 'Forests' is perfectly sound and justifiable how are we going to insure that the national, not to say perhaps real provincial interests, do not suffer from the transference of control ?

If we follow the examples of other countries there are two main courses of action open. Firstly, the Government of India could take over the more important forests in India and manage them directly. This is the principle adopted by the Federal Government in the United States of America. It is hardly suited to conditions out here as many of the most important timber producing forests do not constitute large solid blocks of forest but small areas separated by tracts of inferior growth. For the Central Government to manage only the important forests would therefore involve much higher administrative charges. Further it would hardly be politically expedient at this stage for the Central Government to deprive provinces of

their most important forests even if it were arranged that the provinces should receive the net revenue of such forests.

The second course is that followed by countries such as Switzerland where the Federal Government exercises control over the management of cantonal forests by making it compulsory to submit working plans for approval and by maintaining a staff of Inspectors whose duty it is to see that the provisions of working plans are carried out. This course seems to be perfectly adopted to Indian conditions. The writer considers that the Central Indian Government should make it compulsory to submit working plans for all important forests to it for approval, and if necessary an inspecting staff should be appointed to see that the provisions of such working plans are properly carried out. As regards the decision as to what particular forests should be considered as important enough to justify the exercise of control by the Indian Government one could to begin with rule out all Protected Forests. Reserved forests in general are rather more difficult to deal with. In view of the fact however that India is as yet in a backward state of industrial development and one cannot tell what forest areas are 'Key' areas and in view also of the fact that a large proportion of the forest areas are in private hands it would be safer to begin with to lay down that central control should be exercised over all reserved forests.

The larger provinces who possess Chief Conservators of Forests and their own Working Plan Circles may not relish the idea of a resumption of control by the Government of India but when it is realised that their own popular Governments may in the absence of such control cause irreparable injury to the provincial forests the prospect of superior control may not prove so unpalatable. The United Provinces at least must have already tasted the bitter fruits of popular Government in the case of Kumaon. In the case of the smaller provinces the advantages of central control are still more apparent. No Conservator of Forests is infallible and the necessity of submitting Working Plans to the Central Government for approval will be an additional sufeguard against any possible introduction of doubt-

fully wise systems of management. Such control after all need not be oppressive. It would be possible for the Central Government to lay down definite principles of management to be followed and provided that these principles were observed it would not need to interfere in the actual details. As an example of such a principle it could be laid down that the rotation to be adopted for all important timber producing forests should be 20 per cent. in excess of the financial rotation and that the period of conversion to an even aged system should not be shorter than the actual length of the financial rotation. If the Local Government and the Central Government disagreed the question could be referred to the Secretary of State for decision. This proposal is not far-fetched. In France important forest questions have to be referred to the President of the Republic himself.

Finally, it is interesting to speculate on the future of the Imperial Forest Service if the proposal to transfer 'Forests' is carried into effect. The writer considers that the time must come when each Province will manage its forests entirely through its own Provincial Forest Service. There will still be a place for the Imperial Service however. The work of the latter will consist in carrying out centralized research and forest education work, and it ought, as recommended above, to consist also in scrutinizing provincial working plans and in performing such inspection work as necessary to insure that approved working plan prescriptions are properly carried out. A further duty might consist in regulating the standard of recruitment to the Provincial Services. Whether such an Imperial Service should be recruited direct or from the ranks of Provincial Forest Officers is a question for the future to decide.

NATIONALIST.

INDIA'S FOREST WEALTH TO-DAY.

*The Forest Department must advertise. Forest Officers must give up their old fashioned shrinking habits and must no longer lurk in the fastnesses of Lachiwala and Mettupalaiyam among the Sal and the Sandal and the bamboos and the canes, too modest to raise their gentle heads to tell the passing timber trader that they are there. If L****n and L***s and L***r sell tea and chocolates and soap by taking acres of space in the *Times* and the *Daily Mail* and by having their typewriters photographed and put in the *Daily Mirror* when they go for a holiday at the seaside, let us do something of the kind.

It is to be feared that our advertisements might lack the snap of some of those produced by the Captains of Industry, at any rate at first. But the great models of the day might be copied occasionally *e.g.*:—

?? Have YOU The Modern Business Instinct ??

BUY OUR FIRST-CLASS SAL SLEEPERS FROM N ******

Cheapest and most durable !

Grown and sawn under expert supervision.

WHY GO TO JAPAN

FOR

BAMBOOS

When you can obtain them at your door
From the D. F. O., Kuchperwahnipore ?

HOUSE-POSTS		HOUSE-POSTS
MATCHES	SUITABLE FOR ALL PURPOSES	MATCHES
UMBRELLAS		UMBRELLAS

* A review of INDIA'S FOREST WEALTH, by A. SMYTHIES, B.A.; *India of To-day* Series, Vol. VI, Humphrey Milford, Oxford University Press, 1924. Price Rs. 2-8-0.

A snap-shot of the Chief Conservator's typewriters going away for the Dusehra holiday would be a novelty in the *Indian Forester*, though they might not be as attractive as the girls from L***s tea-shops on a similar journey.

Bookstall literature gives first rate publicity and Mr. Smythies has produced an attractive little volume, called Volume VI of the Series "India of To-day" published by Humphrey Milford, Oxford University Press, Bombay, Calcutta, Madras. The frontispiece is a splendid photograph of a wild elephant in a bamboo forest taken by Mr. F. W. Champion, illustrating those two important items of India's forest wealth. Mr. Smythies sets out to give in a short and readable form an account of the wonderful store-house of forest wealth we have in India, which is, in places, hardly touched.

Sir Peter Clutterbuck, Inspector-General of Forests, in an introduction draws the attention of the readers to the fact that the department controls 160,000,000 acres, about one quarter of the area of British India. Some of these forests bring in as much as Rs. 15 net per acre per annum, and if we could raise the average net revenue to Rs. 3 the total net annual revenue would be £32,000,000. He says,

"This is not too high an ideal to aim for.

> The greater part of the forests is not yet intensively worked and in fact there are very large areas still which are not worked at all. These await development, chiefly the improvement of communications. Also the growing-stock in the forests which are intensively worked has in many cases increased enormously as the result of conservation, protection, tending, and in some cases planting, during the past sixty years. This increase of value in growing-stock as a direct result of the work of the Forest Department, is not sufficiently emphasised in any of the usual reports for the simple reason that we have no ready means of estimating the value of the growing stock for such large areas at frequent intervals. We do, however, know instances that will illustrate this

point. In one case thirty-seven years after the crop had been accurately measured the volume was found to be actually four times greater than it was at the previous survey in spite of heavy fellings of over-mature trees which had taken place in the mean-while.

The proper conservation of forests has been the policy now for about fifty years. The new crops that have been nursed up during this time in place of the more or less ruined crops which previously existed are now about half grown. It may be stated with safety that in a great many parts the revenue has up till now been, and still is, derived from the remnants of forests which had been more or less ruined before the Forest Department came into being, whereas the revenue of the future, after a few more decades, will be from the new crops referred to above. This clearly shows that provided the policy of conservation is maintained the revenue in the future will undoubtedly increase by leaps and bounds as time goes on."

All forest officers will agree with these remarks, at the same time being well aware that nothing like the progress he hopes for can be expected unless we continue to employ a large and increasing number of expert and conscientious forest officers, who will live in their forests. That is really the point. they must live in their forests as Brandis, Schlich and many of the other old heroes did.

Mr. Smythies describes the importance of forests before the dawn of civilization when forest trees monopolized most of the fertile tracts of the globe. As we know, man has been the great destructive agency as regards forests, and we may well conjecture what the Neanderthal and Taungs beings would have thought if they had been asked to realise what forests would really mean to their degenerate descendants.

The author believes that the greater part of India was once covered with forests except in the great desert areas and draws attention to the remarks of the Chinese pilgrims (600 B. C.) who

wandered through the dark forests of Gorakhpur and Western Bengal, where now little remains but a few mango groves. We may note the names of ancient worthies who did good work for the Department, Wallich in 1827, Helfer in 1837, Gibson in 1847, Cleghorn in 1856, and Lord Dalhousie, who first laid down a definite forest policy in 1855. It was no light task for Brandis and many of the other bygone stalwarts to induce the governing powers to take their part against the vested interests which existed, but we must thank their perseverance for much that we have to-day. The author describes in an interesting way various afforestation schemes and gives an excellent sketch of the many classes of forests deciduous, evergreen, littoral, etc., containing the numerous varieties of valuable hardwoods and the fewer softwoods for which India is famous. Not only timber but the valuable minor forest products are enlarged upon and it is useful to mention among these rosin and turpentine, bamboos for paper pulp, lac, tanning and dyeing leaves, fruits and barks, essential oils, resins, cutch, drugs, canes and fibres. The author touches upon the last chapter on future possibilities, a fascinating subject full of hope as long as we may count on the help of provincial legislative Councils. It is somewhat astonishing to be told that India only consumes $1\frac{1}{2}$ cubic feet of timber per head per annum while Great Britain consumes about 8 times as much per head. It is useful to remember that Burma and Assam, for example, have large untouched areas of forests and also that many of the Indian forests are only worked for a few timbers. Suggestions are made for future development of the forests of the Indian Empire. Some good illustrations add to the value of a most readable handbook.

THE MODERN MARKING OFFICER.

In the *Journal of Forestry* for March 1925 under the title "Silvicultural practice in the United States during the past quarter century" appears an article much of which deserves the careful attention of foresters in India.

The author compares empirical silviculture, where a set of marking-rules in the hand of an ignorant man is considered sufficiently good silviculture, with the work of the man who really knows his job. Preston writes,

> "I do not condemn marking rules *per se.* In so far as they establish policy and control the general plan of cutting, they are useful and will probably always be used. Marking rules of this character carried into execution by foresters fully trusted and competent to exercise that degree of freedom essential to enable them to take full advantage of the opportunity offered to put the forest in the best silvicultural condition, are a help rather than a hindrance. It is only when the rules are used as a substitute for silvicultural talent or actually hamper its development that they are objectionable."

How often in India is the marking of a silvicultural felling done by a man who is really utterly incompetent to carry it out? With the marking-rules in his hand he labours to carry out a mechanical operation often in complete ignorance of what he should be trying to accomplish. Trees to him have no life, the forest conveys no intelligent meaning, with the result that the end of his labours generally leaves the forest worse rather than better. How often is a marking seen displaying the most obvious signs of inability to judge the correct thing to be done under the varying characteristics displayed by the crop on the ground?

It may be thought that the above is only an attribute of the lower grades of the staff, and we may be tempted to console ourselves with the idea that a college education has made us skilled in this part of our profession; but such thoughts are an

idle delusion. Silvicultural skill is by no means proportionate to pay. Excellent work has been done by all grades of the staff but we must confess that these men are all too few.

Preston emphasises that need for the skilled application of forestry knowledge to the job of growing timber not the mechanical or empirical application of rules—but a skill born of an intimate knowledge of trees and types and sites, aspect, slope, mixtures and diseases. He asks,

> "Where are the great number of skilled silviculturists that we need? Do the forest schools turn them out? Of course not. Has the forest service developed them? I mean not the theorists, but men who have made a reputation because of their skill in growing crops of timber. It must be acknowledged that the number of silviculturists developed by the forest service is very, very limited."

Can we honestly say that the above is not true of us? and if it is true why should it be so?

THE INDIAN FOREST SERVICE, 1875—1925.

A COMPARISON OF THE NUMBER OF GAZETTED OFFICERS EMPLOYED IN APRIL 1875 AND IN JULY 1924 IN THE IMPERIAL AND PROVINCIAL FOREST DEPARTMENTS OF BRITISH INDIA.

Posts.	Number of posts in April 1875.	Number of posts in July 1924.
Inspector-General of Forests ...	1	1
Chief Conservators of Forests ...	...	6
President, Forest Research Institute and College.	...	1
Conservators of Forests	10	33
Deputy and Assistant Conservators of Forests.	77	251
Sub-Assistant Conservators of Forests	16	...
Extra Deputy and Extra Assistant Conservators of Forests.	...	264
Forest Research Officers at Dehra Dun (Imperial Service Rank).	...	14
Forest Research Officers at Dehra Dun (Upper Grade Assistant, etc.).	...	11
Forest Research Officers in the Provinces (Imperial Service Rank).	...	7
Educational Staff at Dehra Dun and in the Provinces (Imperial Service Rank).	...	12
Educational Staff at Dehra Dun and in the Provinces (Provincial Service Rank).	...	12
Forest Engineers	...	17
Special Gazetted Posts	...	25
Total ...	104	654

THE HONORARY EDITORS OF THE INDIAN FORESTER, 1875—1925.

W. Schlich	July 1875 to
J. S. Gamble	July 1878 to
W. R. Fisher	July 1882 to
E. E. Fernandez	January 1889 to
J. S. Gamble	July 1891 to
J. W. Oliver	January 1897 to
J. S. Gamble	January 1898 to
H. C. Hill	January 1899 to
J. W. Oliver	July 1899 to
A. G. Hobart Hampden ..	April 1903 to
E. P. Stebbing	July 1903 to
E. P. Stebbing and **R. McIntosh**	January 1904 to
E. P. Stebbing	January 1905 to
W. H. Lovegrove	June 1907 to
H. Jackson	October 1907 to
P. H. Clutterbuck .. .	November 1907 to
L. Mercer .. .	January 1911 to
R. S. Hole	May 1913 to
L. Mercer	October 1913 to
B. B. Osmaston	March 1916 to
W. F. Perrée	February 1919 to
R. C. Milward	April 1920 to
W. F. Perrée	November 1920 to
D. R. S. Bourke	September 1922 to
C. F. C. Beeson .. .	April 1924 to present date.

During the period 1911—1922 Rai Bahadur Nand Mal and Mr. J. E. Macpherson assisted the Honorary Editors.

EDITORIAL.

The Honorary Editor regrets that lack of space has necessitated the omission of some of the usual monthly features, *viz.* the Gazette Notifications, the List of Books and Publications, Letters from Correspondents and Domestic Occurrences.

It is hoped that the August number will include the numerous letters recently received.

VOLUME LI NUMBER 8

INDIAN FORESTER

AUGUST 1925.

THE PROGRESS OF SILVICULTURAL WORK IN BURMA.

(Continued from Indian Forester, LI, 7, page 344.)

REGENERATION OF FORESTS UNDER THE REGULAR SYSTEM.

Successful experiments started by the late Mr. J. Messer early in the century in the Mohnyin forest in Katha Division and carried on by Mr. W. T. T. McHarg had shown that clear felling and burning in the presence of seed bearers was sufficient to bring up a copious natural regeneration of teak. It was noted that most of this regeneration sprang up from seed that had been lying in the ground for two or three years and was not to any extent due to the teak seed which had fallen in the year of felling and burning. This question culminated in the drawing up of the working plan for the Mohnyin forests where the clear felling system with natural regeneration was prescribed. Regeneration work under this plan was an important influence on the methods adopted over the Province later on and it is interesting to describe the progress of these operations briefly.

The first regeneration felling under the Mohnyin working plan was carried out in 1911. The area felled over was practically pure teak forest over the greater portion of the area. Copious natural regeneration resulted which with thorough weeding produced a densely stocked crop. The results of natural regeneration were however not as good in many ways as the result of

planting up a small area that had originally been stocked with evergreen species and in which there was previously no teak. Unfortunately over a considerable area regenerated it was decided to experiment with successive annual burning in lieu of a thorough weeding during the rains, and at the end of the first rains it was perfectly obvious that this could not be successful as, owing to the dense growth of weeds, all the regeneration, which was extremely plentiful, had been killed. Under the plan regeneration fellings had been prescribed over one compartment in each sub-period of five years so that no further fellings were carried out until 1916. In 1916 it was decided to regenerate 1/5th of the sub-periodic regeneration area annually and the use of the *taungya* cutter was experimented with over part of the area. Where teak seed bearers were present on the area before cutting, natural regeneration in the *taungya* area was very successful and the transplanting of blanks in this area was also carried out successfully. It was realized that natural regeneration depended on the presence of a very large number of seed bearers in the crop before regeneration and this condition was not present in all the areas regenerated nor was it characteristic of the vast majority of the forests in the Province. In 1917, therefore, the method of regeneration over a considerable portion of the area was changed to artificial reproduction with *taungya* and thus, after having fallen into disrepute in 1905-06 on account of the badly organized manner in which *taungya* plantations had been carried out, this form of regeneration on an organized plan of working on the clear felling system again came into its own. In the mean time successful natural regeneration work had been carried out in the North Toungoo division where approximately the same method *i.e.*, clear felling and burning had been adopted as in the original work in the Mohnyin reserve. These operations prepared the way for the more general adoption of the uniform system, and on the commencement of work under the Tharrawaddy Yoma Forests Working Plan the clear felling system was adopted over a much larger area and experiments in regeneration made in 1918 rapidly showed that the *taungya* plantation was far and away the cheapest and most efficient method of regenerating

teak forests in Burma. Under the Tharrawaddy plan the following areas were regenerated :—

1918	...	...	263 acres.
1919	...	...	556 "
1920	...	...	982 "
1921	...	...	634 "

The area laid down for regeneration under the plan which was calculated as 1/120th of the total area considered suitable for teak was 1,100 acres. Efforts were being made to work up to this area in 1920 but it was found that the removal of all marketable timber before regeneration could not keep pace with regeneration and in 1921 and later the area had been reduced to about 500 acres per annum. Success under the Tharrawaddy Yoma Working Plan led to considerable increase of regeneration under the *taungya* method. For instance, in Zigon division in 1920, 1,072 acres were regenerated. In 1921 this was increased to 1,421 acres. Here too, however, the difficulty of removing marketable timber before regeneration led to a decrease in the area in the following year and indeed under the recently revised working plan for the Zigon division the annual regeneration area has been reduced to 612 acres as it was found that it was not advisable to work over the whole of the division on the clear felling system and the less accessible forests were left under the Selection system. In the North Toungoo division considerable progess was also made. The progress in regeneration may be gauged by showing the total area of plantations as they stood on the forms on the 31st March 1924 and these may be compared with the figures given above for the position on the 30th June 1918.

Regular plantations	...	...	4,419 acres.
Taungya "	...	...	98,740 "

This shows an increase of over 20,000 acres in the six years as compared with an increase of only just over 4,000 acres under *taungya* plantations in the preceding eleven years.

Earlier in the period plantation work had been practically confined to teak with the exception of a few miscellaneous experiments mostly with exotics. It was not until about 1916 that attention was turned to the question of planting

other species. Early efforts with *yemane* in the Mohnyin working circle, Katha Forest Division, showed considerable promise and later, when the regeneration under the Tharrawaddy Yoma Working Plan was commenced, experimental planting with a very large number of different species was attempted. At the present time regeneration work is by no means confined to teak and the present policy is to plant that species which is considered to be most suitable for the locality, teak being planted on the most suitable soils and the other species mainly being planted include *pyinkado (Xylia dolabriformis)*, *taukkyan (Terminalia tomentosa)*, *padauk (Pterocarpus macrocarpus)* and several others with a tendency to reduce the number of species planted and to concentrate on a few of the more valuable species. A certain amount of attention also is being paid to the reproduction of *Eucalypts* with a view to producing early returns of fuel in areas where the demand for fuel is very great. Until recently practically all regeneration or improvement work had been confined to areas growing or capable of growing teak but within the last few years increasing attention has been paid to other types of forest more especially of the type of forest characterized by a predominance of *in (Dipterocarpus tuberculatus)* and generally to accessible areas with a view to providing for domestic requirements.

AFFORESTATION.

Little has been done under this head until the last few years when afforestation work was undertaken in the Bhamo-Kachin Hills in order to restock areas that had been denuded of forest by repeated *taungya* cutting and burning. The object is partly to avoid excessive denudation and also partly to provide forest growth in which the local inhabitants may continue to cut *taungyas* under proper control. Owing to the complete denudation of all forests the country was no longer able to carry its population and there was the danger that the area would become depopulated. The work is at present only in the experimental stages and consists of the broadcast sowing of *maibau (Alnus nepalensis)* combined with continued fire-protection.

COSTS.

The following statement shows the expenditure on planting and works of improvement during the period :—

		Sowing and planting.	*Cultural operations I.F., C.C. & other works of Improvement.*	*Total.*
1900-01	...	60,570	13,548	74,118
1905-06	...	151,563	49,012	200,575
1910-11	...	69,307	116,560	185,867
1915-16	...	29,884	99,804	129,688
1919-20	(1920-21 was incomplete owing to change of forest year to end 31st March.)	46,860	92,064	139,924
1923-24	(Last year for which figures are available.)	138,760	60,767	199,527

It is interesting to trace the reduction of expenditure on sowing and planting and the increase in expenditure on other works towards the middle of the period with the later increase under sowing and planting in the last few years of the period due to the return to favour of *taungya* plantations properly organized under the clear felling system.

TENDING OF PLANTATIONS.

Up to the beginning of the 20th century there had been no organized thinning in teak plantations. The original idea of teak *taungya* plantations was that they would be by no means fully stocked and could be allowed to grow on without very considerable tending or thinning. Later, however, completely stocked areas of *taungya* teak plantations had been created and at the

start of this period the question of thinning such large and scattered areas was causing considerable difficulty. Indeed it was very largely this difficulty that led to the restriction of further *taungya* cutting in 1906. Following on this restriction considerable attention was paid to thinnings in plantations and in many divisions regular schemes for carrying out these thinnings were drawn up. One of the earliest schemes to be drawn up on sound lines was that for the Tharrawaddy Division drawn up by Mr. F. A. Leete who shortly afterwards embodied the results of research work into teak *taungya* plantations, in a forest records entitled "Memorandum on teak plantations in Burma." Mr. Leete recommended that teak plantations should not be thinned until about the 15th year when it was considered that the struggle for existence had proceeded sufficiently far to have allowed the bole of the teak trees to have cleaned themselves up to a sufficient height. More recently there has been a further development in the tending of plantations following on the experience gained under the Nilambur plantations and as summarized by Mr. R. Bourne in his working plan for the Nilambur plantations, Madras. Thinnings are now being adopted at a very early age as soon as the canopy has become closed up. It was found from experience that by leaving teak plantations unthinned up to the age of 12 or 15 years the crowns became considerably constricted and were unable to take full advantage of the thinning. It has now been fairly satisfactorily proved that at no stage of its existence should a crown of a teak tree be unnecessarily restricted. While plantations should be allowed to close up sufficiently to clean off the lower branches and prevent growth of a branchy habit it is essential to allow a full development of the crown in order to attain a rapid growth. There can be little doubt that the girth increment of plantation trees can be very considerably increased by early and repeated thinnings. With the introduction of the clear felling system the tending of plantations has once more become extremely important and regular schemes for carrying out thinnings over whole compartments once every five years combined with cleanings have been drawn up for the great majority of Divisions in Burma.

FIRE-PROTECTION.

The best description of the earlier history of the question of fire-protection during the period is given in the "Note on the Tour of Inspection in Burma," dated the 4th March 1914, para, 9, by the Inspector-General of Forests, Mr. now Sir George Hart, K.B.E., as follows:—

"*Summary of past history.*—The first public expression of doubt as to the advisability of continued fire-protection in the teak forests of Burma is to be found in an article written by the late Mr. Slade and entitled 'Too much fire-protection in Burma,' which was published in the *Indian Forester* for May, 1896. This subject was carefully considered in 1897 when it was decided on the advice of the then Inspector-General of Forests, Mr. B. Ribbentrop, that fire-protection should be extended as far as funds and administrative considerations allowed, with the result that between 1896-97 and 1906-07 the area under protection rose from 1,856 sq. miles to 8,153 sq. miles.

"The decision of 1897 did not, however, satisfy many Burma forest officers and the opposition to the continued protection of all classes of forests continued to grow steadily. In the *Indian Forester* for March 1905 Mr. Troup published the results of enumerations of the stock carried out in two adjoining plots in the Tharrawaddy forests, one of which had been protected successfully for 19 years, and the other of which had been burnt over annually. These enumerations were confined to poles of 1 foot to 2 feet in girth, to poles and saplings under one foot in girth, and to seedlings. Reduced to the numbers to be found on 50 acres they showed (*i*) a much larger proportion of unsound and dead stems to sound stems in the protected plot, (*ii*) ten times as many seedlings in the unprotected plot as in the protected plot and (*iii*) that about half the sound stems in the protected area were in danger of suppression and would probably disappear, while those in the unprotected plot were mostly sound, well-grown, without sign of fire damage and in little danger of suppression. Mr. Troup concluded that with continued protection teak must eventually disappear from the protected plot.

In the cold weather of 1906 Mr. Beadon-Bryant, then the Chief Conservator of Forests, visited the Tharrawaddy Division with the object of obtaining further information as to the effects of fire conservancy, and arranged to have further countings made. Among the plots counted on this occasion were four, covering an area of 275 acres, which had been enumerated 22 years previously when the working plan was made. The results obtained in these plots, and in six others, confirmed generally the conclusion arrived at by Mr. Troup, *viz.*, that the decrease in the number of teak stems below one foot and between one foot and one foot six inches in girth was most conspicuous in areas which had been continuously protected from fire for many years.

In 1907, Mr Bryant compiled a valuable memorandum on fire conservancy in Burma. After summarising the past history and dealing with the countings made in the Tharrawaddy forests, which he considered to have proved conclusively that prolonged fire-protection had resulted in a marked decrease of the younger classes, he recorded, as the result of his many tours in the province, the opinion that the combination of the selection system with fire-protection was gradually but surely killing out the teak in all the moist forests of Burma, that is to say, over hundreds, if not thousands, of square miles. He then referred to the benefits to be derived from fire-protection and proceeded to classify the forests of Burma into three groups :—

(*a*) Forests in which the valuable species are found with an undergrowth of evergreen, dense, periodically and gregariously flowering bamboos, as well as forests of a moist evergreen nature where, with the aid of fire-protection, evergreen is encroaching on the teak.

(*b*) Forests with an undergrowth of less dense bamboos which flower sporadically as well as gregariously, and therefore, are more favourable to reproduction.

(*c*) Forests with an undergrowth of shrubs, herbaceous plants, and grasses only, in which the more valuab e

species occur in a mixed or pure state (the latter mainly confined to cutch).

He considered that fire-protection should be abandoned in class (*a*), that it was probably beneficial in many forests of class (*b*), though, perhaps, not possible to maintain owing to the manner in which classes (*a*) and (*b*) are intermixed and that it was certainly beneficial in class (*c*) where it should be continued and extended.

" Mr. Bryant submitted his memorandum to the Local Government through the Inspector-General of Forests who, while agreeing generally to the proposed classification and treatment, was unable to recommend that these should be brought into force at once, and advised that in each circle or division suitable areas of sufficient size should be selected, where the effects of the abandonment of fire-protection could be carefully watched and the system extended from year to year, if the results justified such action. These recommendations were accepted by the Local Government and the necessary orders were issued in October 1907. Subsequent to this, there is nothing of particular importance to note, for the Burma Conference of 1910 does not appear to have paid very much attention to this important subject, confining itself to passing a resolution that fire-protection in plantations is ordinarily unnecessary after ten years.

' In 1907-08, when the orders referred to above were issued, fire-protection was in force over 7,527 sq. miles. In 1911-12, the area over which the protection was attempted, amounted to 6,750 sq. miles. In other words there has been a reduction of ten per cent. which, though it may be regarded as a start, can hardly be said to prove the general adoption of the views set forth by Mr. Beadon-Bryant in 1907......"

Sir George Hart recommended that the classification advocated by Mr. Beadon-Bryant should be carried out over every forest division in Burma and that subject to certain reservations fire-protection should be abandoned in class (*a*), *i.e.*, forest in which the valuable species are found with an undergrowth of evergreen dense periodically or gregariously flowering bamboos, as well as forests of a moist evergreen nature where with the

aid of fire-protection evergreen is encroaching on the teak. He did not advocate that the abandonment of fire-protection in any class of forest should be necessarily either total or permanent and suggested that fire-protection should be given up for a period to be followed by further protection. He pointed out, however, that the results of fire-protection likely to be attained might prove to be incommensurate with the expenditure involved.

Following Sir George Hart's inspection reduction of fire-protection was slow and only gradually accomplished in spite of the opinion of the vast majority of forest officers in Burma in favour of considerable abandonment. The figures are as follows:—

Year.		*Area in sq. miles.*	*Cost.*	
			Rs.	
1913-14	...	4,548	2,00,528	
1914-15	...	3,378	1 44,499	
1915-16	...	2,680	1,14,048	
1916-17	...	2,474	1,12,867	
1917-18	...	1,750	76,449	
1918-19	...	1,347	65,384	
1919-20	...	1,277	58,877	
1920-21	...	1,215	25,055	
1921-22	...	697	25,055	9 months only owing to Forest year being altered to 31st March.
1922-23	...	122	13,742	

The area fire-protected in 1923-24 was only 142 sq. miles at a cost of Rs. 16,731, a very considerable reduction from the figures given by Mr. Hart for 1911-12 when fire-protection amounted to 6,750 sq. miles at a cost of Rs. 2,43,726. The present policy with regard to fire-protection is generally to confine it to regeneration areas or outside such areas, to areas where it is known to be beneficial and financially justifiable.

Within the last three or four years there has been a section of the Department in favour of giving up fire-protection in young regeneration areas in favour of early and repeated burning. It is believed that the disadvantages of this method, in that it delays the closing of the canopy, have now been proved. At the same time unless fire-protection in young regeneration areas can be absolutely certain early burning does form a better insurance against the damage of a late fire. With the exception of regeneration areas fire-protection must be for the present experimental in areas of dry forest. Although fire-protection in dry areas is undoubtedly beneficial, it has still to be proved that the operation is financially justifiable.

OTHER MATTERS BEARING ON SILVICULTURAL PROBLEMS.

Flowering of kyathaung bamboo.

The *kyathaung* bamboo (*Bambusa polymorpha*) is the characteristic bamboo of the Pegu Yomas on which are situated the finest teak forests in Burma. It is on the areas on which *kyathaung* flourishes that teak attains its best quality. As far as is known the *kyathaung* flowered last in the period 1850—1860 and for some years a general flowering of this species has been awaited. Early in the twentieth century the problem of how best to face the general flowering was engaging the attention of all Forest Officers in Burma. Definite plans for concentrating Forest Officers on the spot in the event of flowering in order to carry out cultural operations over as large an area as possible were drawn up. Years went past and with the exception of a few cases of solitary clumps flowering (everyone of which gave new cause for alarm) the bamboo still refused to flower. The most noteworthy flowering was over

several small areas totalling two or three sq. miles in the Tharrawaddy Division in 1918-19 and this was on such a general scale over small areas that the immediate flowering over the whole of the Pegu Yomas was confidently awaited.

Flowering also took place in the years 1922-23 and 1923-24 over limited areas in the North Toungoo Division. Reports of sporadic flowering in the season 1924-25 over considerable areas in Tharrawaddy Division are to hand.

The question of taking steps to make the best use of the opportunity of flowering were again brought into prominence in 1919 and there was considerable discussion as to the methods to be adopted. Experiments in clearing of gaps in *kyathaung* forests and sowing of teak seed carried out in 1920 proved that the method was extremely expensive and could not be carried out over very large areas. In the meantime regeneration by means of *taungya* plantations under the clear felling system had come into its own and it was decided to concentrate *taungya* plantations as far as possible in the *kyathaung* areas prior to the general flowering. It was by now realized that so far from being a help to regeneration the general flowering of *kyatkaung* would be a calamity. By far the best results in *taungya* plantations are obtained in dense *kyathaung* forests where there is otherwise very little growth of trees and the complete flowering of these bamboos would so reduce the area suitable for *taungya* plantations that considerable difficulty would be experienced in carrying on regeneration under the uniform system. As matters now stand regeneration is to a certain extent being concentrated on *kyathaung* areas. It is probable that flowering will gradually increase yearly and a general flowering over the whole of the Pegu Yomas will probably carry on over a number of years before it is complete.

With the introduction of the clear felling system it is not desirable to do more than concentrate on regeneration work in the regeneration block and it is doubtful if more considerable work outside the regeneration block can usefully be done when the bamboo flowers. Experiment in cases where other kinds of bamboos have flowered have shown that although regeneration of

of teak in the year of flowering and the subsequent years also is fairly prolific it is rapidly caught up by the young bamboo and a very considerable proportion is killed out unless assisted by cleanings. It is probable that the best way to meet the general flowering will be to alter the regeneration blocks so as to include a number of compartments on which other bamboos are prevalent and to carry on in them until a time when the young *kyathaung* shall have attained sufficient size to enable it to be cut over for *taungyas.* It has been proved by experience that in the case of *tinwa (Cephalostachyum pergracile)* and *myinwa (Dendrocalamus strictus), taungyas* cannot be cut with any certainty of success until the bamboos have reached a stage where clumps are definitely formed. If *taungyas* are cut in bamboo growth before this stage is reached the weedings and cleanings of the young bamboo growth which, instead of being killed out by the *taungya* fire, springs up very densely, become so expensive that *taungya* operations are extremely difficult.

RESEARCH.

During the early part of the period there was no organization for the carrying out of any research work in Burma. It was not until the return of Mr. A. Rodger, O.B.E., from leave at the end of 1913 that the post of Forest Research Officer in Burma was created. Mr. Rodger's duties were of a general character. Besides Silviculture he also did a considerable amount of work in Botany, Utilization, and even work connected with investigation of the beehole borer, not to mention acting as controlling officer for working plans and advisory officer as regards the preparation of working plans. It was, of course, soon obvious that no single officer could hope to make much progress with so many different branches of study. Moreover, in 1917, Mr. Rodger's services were placed at the disposal of the Munitions Board for the control of timber operations carried out by the Province for the supply of timber for Munitions purposes and little work in the way of research could be done until the end of 1920. In the meantime a considerable amount of research had been carried out by the various Divisional Forest Officers and results more especially with regard to sowing

and planting of tree seedlings in *taungya* operations are combined in a publication issued towards the close of 1919. At the beginning of 1920 the post of Conservator of Forests, Working Plans and Research was created. The post of Silviculturist was created at the close of 1920 and from that time no progress was made on the side of silvicultural research. A series of sample plots in teak plantations has been laid out. Statistical information on the volumes of trees of various species have been collected and numerous experimental plots have been formed. In addition to this a system of ledger filing of information has been started together with a photographic record. A research library is now in course of formation. With the creation of the Silviculturist's post it was decided to commence a series of publications in order to publish results of work done or information received as soon as possible to officers in Burma. The object of these publications is not antagonistic to the publications of the Forest Research Institute at Dehra Dun as the matter compiled for the Burma Forest Bulletins is usually composed of interim reports or matter mainly of interest to Forest Officers in Burma.

Perhaps the most useful side of the Silviculturist's branch has been the formation of a central advisory post working in close connection with the Conservator of Forests, Working Plans Circle. It has allowed for a wider view being taken for the whole Province and a gradual formulation of policy which it is hoped may be more continuous than in the past.

H. R. B.

SILVICULTURAL NOTES.

SAL COPPICE AND BURNING.

An area in the Western Dun in the Dehra Dun Forest Division was felled over in 1923-24 with only about twenty *sa*

trees per acre left for shelter. In the cold weather of 1924-25 all the advance growth, saplings and poles up to 8" diameter were cut back at from 3 to 6 inches above ground-level. This work was begun in the middle of November and proceeded methodically throughout the compartment finishing early in March. The area was burnt, with a good clean, but not too severe, fire, on March 15th-16th. The area was carefully inspected on April 28th, *i.e.* exactly six weeks after the burning. The area was then completely stocked with strong *sal* shoots with on average height of about two feet, many shoots were over three feet and one was measured just over four feet in height. Previous to the felling in addition to the overwood the area was fairly well stocked with *sal* seedlings in the "whippy" stage, misshapen "woody advance growth" three to four feet high and about as thick as a man's finger, small poles and saplings.

The development of the shoots from material in different stages was as follows:—

(1) Older seedlings which were in the "whippy" stage have given fairly strong shoots up to 1½' and in some cases 2' in height.

(2) The misshapen "woody advance growth" has given shoots of an average height of 3' with one measured just over 4'.

(3) Saplings and small poles up to 6" diameter, shoots up to 1½' with an average of about 1' in height.

(4) Large poles—up to six weeks after the burning no shoots at all or shoots only just beginning to appear.

Other points of interest are:—

(1) There is absolutely no difference whatever in the development of the shoots in the areas cut back in November-December or those in February and early March.

(2) In all cases where the burning has been clean the shoots have appeared from below ground-level.

Although the burning was clean there are a few small patches which escaped burning either where there was nothing to burn

or on cart tracks, etc. The general development of the shoots in these unburnt patches is very little, if any, behind that of the burnt areas.

However where the advance growth, which often has a gnarled swollen collar, was cut back a little too high, shoots, in the unburnt areas, have invariably appeared from above ground-level, and cannot therefore develop into good trees.

W. A. BAILEY, I.F.S.,
Dehra Dun Division.

REVIEWS.

"SCHLICH, VOLUME THREE."

FOREST MANAGEMENT (Volume III of Manual of Forestry), Fifth Edition, by SIR WILLIAM SCHLICH, K.C.I.E., F.R.S., etc., 1925

It is almost exactly 20 years since the distinguished author produced the last edition of his volume III, Forest Management, during which time there have been many important developments in forestry as in all other things and we find, as we might expect, considerable changes, alterations, and additions in this edition as compared with its predecessor. It is still divided into the same four main parts: I Mensuration, II Valuation, III Foundations of Forest Management, and IV Preparation of Working Plans.

In Mensuration we do not find many changes or additions but the description of the "measurement of standing woods" has been enlarged by a detailed description of the British Forestry Commissioners' method, and one or two others of less importance. In Valuation, a good deal is now omitted which was in the earlier edition, and although this part still bristles with the vast and complicated looking formulæ that many of us used to struggle with 10 or 20 years ago, yet the subject is now dealt with in a simpler, shorter, and clearer manner than formerly. Especially is this the case with the chapter on "the financial results of Forestry," which is practically quite new. As regards parts III and IV, as the author states in the Introduction:—

> "A great part of Management has been rewritten on the basis of further experience gained since the publication of the fourth edition Several new methods of treatment have been added, specially elaborated with the object of improving the process of regeneration and the preservation of the yield capacity of the soil Foresters of expeience have recognised the importance of returning to the former practice of regenerating the forest under one of the shelterwood systems, whenever the quality of the soil is not of a high order

and the climatic conditions unfavourable, planting and direct sowing of the seed on bare land being restricted to new afforestations, to places where natural regeneration has failed and in some cases to the cultivation of highly light-demanding and quick growing species."

Special attention has been paid to the regulated selection system, which was very inadequately dealt with in the previous edition.

Regarding the gradual introduction of more elaborate and concentrated systems of management within the Indian Empire, the author notes—

"In India, apart from small experiments, it took 50 years of strenuous work before substantial progress with the conversion of the selection system into the compartment or uniform system could be begun; even now the area taken in hand for that purpose is as yet a small part of the total area of the forest under the management of the Forest Department. Besides, such conversions have yet to prove that they are the blessing for the country which their promoters expect them to be."

It is impossible in the course of a short review to discuss the whole contents of the volume in detail, and in the following notes only a few points will be picked out for consideration, points which are at the present time of practical importance in Indian Forest Management.

In part I, about 16 pages are devoted to a consideration of yield tables, but two points which have exercised the minds of Indian foresters are not referred to at all, *i.e.*, (1) Can a yield table be made for species without annual rings, and where therefore the ages of sample plots are not known? (2) To what extent can the figures of a yield table be applied to an irregular or selection type of forest, *e.g.*, in the calculation of increment, or the density of stock compared to normal?

In Appendix IV, the present edition varies greatly from the previous edition, in that *British* yield tables (prepared and

published by the Forestry Commissioners) are given for larch, spruce and scots pine, German yield tables for silver-fir, oak and beech, and the U. P. *sal* yield table also finds a place.

In the preliminary discussion of Forest Working Plans, the author has included two coloured plates, with different colours for different types of forest (oak high forest, conifer high forest, coppice, etc.) which explain clearly to the student the meanings and objects of such expressions as working circle, cutting series, sub-compartments, etc., and should prove most useful.

Let us consider another point which has caused a good deal of controversy and correspondence in India. What is the Normal Selection Forest ?

The importance of realising what it is, of getting some concrete figure of growing stock in one's mind, is well brought out in the following sentences :—

> "Throughout all stages of treatment the yield must be intimately connected with the increment. The one must be equal to the other in all cases where the proportion between the classes is such that the objects of the proprietor can be indefinitely realised ; in other words, if the growing stock is normal. If there is either a deficiency or surplus of growing stock in the one case less and in the other case more, then the actual increment should be cut, as a temporary measure, until the normal condition has been established." But then the author goes on to say, "It is not possible to define the normal condition of the growing stock by a formula, as can be done in other systems. It can only be described as that which yields permanently the greatest return of the class of the timber described by the proprietor."

This is really of very little assistance to the student or practical working forester. In effect the author says :—

> "It is essential in calculating the yield to compare the normal with the real growing stock, but I cannot tell you how to calculate it."

He goes on—

" The normal state can, as a rule, be reached only gradually in the course of several periods, during which the forester establishes the proper proportion between the several size classes."

Yes, but what is the proper proportion ?—

" Their numbers should be such that each tree is given enough growing space required for full development and no more, according to the size class to which it belongs, and the light required for the proper development of young growth. With this reservation, a full stocking of the area should be aimed at, so as to obtain a full return, and to produce as clean and well shaped boles as may be possible under the existing conditions."

We maintain that all this is much too nebulous for practical working conditions, and the practical forester requires some thing much more concrete in his mind before he can tell whether this fellings and management are tending to bring his forest into a normal state or not. It is just here that Trevor's curves, comparing the real normal growing stock of group-selection forests are so useful to the forester, as they supply the concrete and definite picture required for practical working, a picture for which neither the author nor Trevor's critics have yet suggested any substitutes. It is recognised that this curve will only properly apply to a group selection system and that in the case of true selection the normal may be somewhat different but with *sal* true selection does not arise. As the groups increase or decrease in size so will the normal approximate to the curve for even aged or true selection whatever the latter may happen to be. The distinguished author has taken up an impregnable position on the fence. At any rate we might have been told more about this subject and the controversies which have ranged round it.

In describing the *management* of the regulated selection forest, the author writes—

" There cannot be any doubt that the successful treatment of selection forests depends more on the

individual efficiency and zeal of the forester than is the case in any other system. To obtain really good results, it is essential that the forester should have a detailed knowledge of all parts of the forest, as he has, so to say, to guide each promising tree throughout all stages of its life. All depends on his personal judgment in the selection of the trees to be left for the further development, of these to be cut, and of the time of removal. Given such a manager, all will be well, but failing this, mischief may be the consequence."

We cordially agree, and it shows the difficulty of applying this system to Indian conditions, with the enormous areas of divisions, and frequently changing Divisional Forest Officers.

In discussing the actual calculation of the yield in a regulated selection forest, the author writes—

"The difficulty is to ascertain the actual increment at starting. An effort may be made to determine it by examining the increment of the immediate past and adopting that for the immediate future, until more reliable data become available." (But many important Indian species have no clear annual rings whereby the past increment can be determined.) "The more reliable data can be obtained only by remeasurements after short intervals of, say, 5, 10, or **n** years. Let the volume in the beginning be **VI**, that after **n** years **Vn**, and the volume removed during the **n** years = **Yp** (**p** = periodical), then the increment during the **n** year amounts to **Ip—Vn—Yp—VI.** In this way the increment for the whole compartment can be ascertained, as well as for each class of trees. With every succeeding periodic measurement, the determination of the increment becomes more and more accurate."

Then comes the following rather astonishing footnote:—

"Several methods have been developed in India by Messrs. S. H. Howard, E. A. Smythies and others, which are very

ingenious, but complicated, nor are they free from uncertainties. In the author's opinion, the above method is the only way of determining the increment accurately." It is evident from this that the author has not clearly realised what Messrs. Howard, Smythies and others have been striving to do. They realise perfectly well that the periodic increment is the best regulator of the yield, and they have not attempted to evolve new methods, ingenious or otherwise, of ascertaining it. But in India we are frequently (we may say at present usually) faced with the problem of *having to fix a yield for a forest where the "actual increment at starting" is not known,* and where "the only way of determining the increment accurately," *i.e. by re-enumerations* simply cannot be followed, since no previous complete enumerations of growing stock have been made. The problem is further complicated in India by the practical impossibility of enumerating the *complete* growing stock of an extensive forest, and by fixing a *practical but comparatively high enumeration limit,* we thereby eliminate growing stock representing a third or even a half of rotation age. It is this problem which several investigators have been trying to tackle, and which the author leaves severely alone. That is to say, he puts the problem quite clearly (but leaves it unsolved) in the example illustrating the regulated selection system :—

> "It is proposed to remeasure the stock at the end of the 10 years, so as to obtain the data necessary for the determination of the periodic increment. As it is not desirable to suspend cuttings during the first period, nor to overcut the compartment, the forester must make the best estimate he can of the probable increment during the first 10 years."

It must be admitted this is not very helpful to the practical working plan officer who has to make the estimate, and fix the yield.

In passing, one more extract from the regulated selection forest may be quoted. In dealing with the *proportion* between the several size classes, the author writes—

> "The most desirable proportion would probably be that which exists if each size class occupies the same area."

This is fundamentally the assumption made by Trevor in dealing with the normal selection forest, which led to correspondence in the *Indian Forester* that will be fresh in the minds of our readers. But if Trevor's assumption is not considered admissible, and as some concrete conception is essential for the practical forester, the only alternative we know defining the proportion of size classes is the assumption of the French 1883 method, which the author mentions, but does not show how it is obtained.

In dealing with the formulæ methods of calculating the yield of a forest, the author describes four. Three of these (the Austrian, Heyers and Hundeshangen's formulæ) require a knowledge of the normal growing stock, and the question naturally arises how it is possible to use any of these formulæ for the calculation of the yield of a selection forest, if, as the author states, it is not possible to define the normal growing stock of a selection forest.

The fourth method is Von Mantel's, apparently the simplest of all, since the yield can be calculated on the figure of real growing stock and rotation. But we cannot help thinking it is a pity that text-books almost invariably ignore the practical impossibility of measuring the *whole* growing stock (down to seedlings), and never emphasise sufficiently that the ignoring part of the growing stock introduces an error in calculating the yield. (It is this error that Messrs. Howard, Smythies, Blanford and others in this country have been trying to eliminate.)

The Uniform System with its various modifications is dealt with in detail, an important introduction since the last edition of this work being the *Quartier bleu* system, which to our minds seems pre-eminently suited to the management of Indian forests wherever natural regeneration has to be chiefly depended on, and can be relied on to be reasonably successful.

Under the section "choice of system" the author has some useful remarks to make. He emphasises that the clear felling system is, generally speaking, admissible only on land which is not only fertile, but also subject to a sufficient rainfall favourably distributed, over the several seasons of the year. In all

other cases, the exposure of the soil to the full effect of the sun and air currents extending over a number of years leads invariably to reduction of the fertility. To prevent this, a system must be chosen which provides for a regeneration under a shelter-wood. Then arises the question: which of the latter class systems is preferable? There cannot be any doubt that of these the regulated selection system gives the best protection, and next to it the uniform system or one of its modifications. The important position given by the author both here and elsewhere, to the regulated selection system, justifies our somewhat lengthy notes on it, in which we have attempted to show that for Indian conditions, it is not nearly such a simple proposition as some of its advocates apparently imagine. We trust that in doing so, we have not given a false perspective of the book under review. Schlich's volume III is so well known to students of forestry in general (and perhaps to the bulk of Indian foresters in particular), that it is only in dealing with the new subject matter of this fifth edition that it is possible to avoid becoming hackneyed.

It is undoubtedly a great advance on the previous edition, and no serious student of forest management can possibly afford to neglect the teaching and information contained within its 370 odd pages.

E. A. SMYTHIES, I.F.S.

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SOME PRIVATE FOREST ESTATES OF CZECHOSLOVAKIA AND AUSTRIA.

In the autumn of 1924 when on study leave Major Caccia, C.B., gave me an introduction to Dr. Heske, honorary professor of sylviculture at the Hochschule für Bodenkultur at Vienna and working plans officer to Prince Schwarzenberg, who invited me to join him on a tour through some of the largest private forest estates in Czechoslovakia and Austria. The tour had been arranged in order to show Dr. Lakari, Head of the Forest Management Branch of Finland, the most modern methods of sylviculture and forest management as practised in Central Europe, and I gladly availed myself of an unique opportunity of visiting Central European Forests particularly as many of the forests lay in mountainous country comparable in steepness to the hills of the outer Himalayas.

Mian Zia-ul-Haq, Extra Assistant Conservator of Forests of the United Provinces Provincial Service, accompanied us throughout the tour, before joining the post-graduate course at the Imperial Forestry Institute at Oxford and everywhere we were both shown the greatest courtesy and hospitality, particularly on the Schwarzenberg Estate.

Political and economic changes since the War have been unprecedented, the old Austrian monarchy has been dismembered, and everywhere there strenuous attempts are being made to conserve and develop natural resources to their fullest extent

1. Spruce woods, 60 years old, established by natural regeneration under a shelterwood. Ernsthausen, Böhmerwald.

2. Kubany "Uhrwald"—virgin spruce, silver-fir and beech forest.

3. Mixed spruce and beech forest along the Schwarzenberg Channel. Note log ready for launching.

and forests in particular receive the greatest attention. In Czechoslovakia the State is taking over the estates of the great landed proprietors and this was one of the last opportunities of visiting the vast Bohemian Forest belonging to the Prince Schwarzenberg before it passes out of private hands. Situated as these countries are close to Russia the evils of Communism are well known and political developments in England are watched with apprehension as it is recognised that England is the main bulwark against the spread of communistic principles: the general election in England, which was held whilst I was abroad, formed the subject of leaders in all the papers and the greatest relief was felt at the failure of Communism to make progress in the British Empire.

THE SCHWARZENBERG ESTATE.

Prince Schwarzenberg owns some 334,000 acres of forests and about the same area of agricultural land, of which about 50,000 acres of forest are situated in Austria, a few thousand acres in Bavaria and the remainder in Czechoslovakia.

The forests are valuable, for the most part are densely stocked, and have been under intensive management for a hundred and fifty years. The Princes have consistently pursued a remarkably progressive yet conservative policy of management and have removed only the outturn sylviculturally permissible, thus throughout successive generations the value of the estate has increased.

The Schwarzenberg family has a distinguished history: an ancestor almost as celebrated as Sobriesky saved Vienna from the onslaught of the Turks in the seventeenth century and drove them out of Central Europe, and a great uncle of the present Prince defeated Napoleon at the battle of Leipsic: throughout its history the heads of the family have been distinguished for financial capacity, succeeding members of the family having added to and increased the value of the family estates.

The controlling Forest Staff is large and is recruited mainly from the Vienna Hochschule für Bodenkultur and sufficient pay and concessions in the way of free houses and farm lands are

given to attract annually the best forest students in Central Europe; bonuses are paid for good results, the social standing of the forest officers is good and service in the Schwarzenberg estate is popular.

The Chief Officer of the Central Forest Direction is the General Forest Director. Under him are several assistants; Secretary for Personnel: commercial utilization, etc., and the Working Plans branch. The Working Plans branch contains eight to ten officers with a president undertaking the preparation of working plans and their control, both in the forests and in the office: the working plan officers are expected to keep in touch with the latest scientific developments and generally are responsible for the woods being managed on correct sylvicultural principles.

The whole forest area of the Schwarzenberg Estate is divided into 12 "Directions:" at the head of each "Direction" is the Forest Director assisted by a "Controller." The size of a "Direction" is from 25,000 to 33,000 acres except for a few intensively worked forests of less extent.

Each Direction is divided into several "Reviers" of which the head is the "Forstverwalter" who is allowed an assistant in the case of the larger Reviers: the size of a Revier is from 2,000 to 7,500 acres. Each Revier is sub-divided into several beats under a "Hager."

Forest Directors, Verwalters and Assistants are University or at least middle-school trained men who have passed the State examinations. The Hagers have mostly undergone a certain amount of training in forestry or at least have been practically trained.

The General Forest Director controls the whole policy and management of all branches.

THE FRAUENBERG ESTATE.

We first visited Frauenberg, the winter residence of Prince Schwarzenberg, where he has a castle designed by an English architect on the lines of Windsor Castle and is picturesquely situated in the midst of oak, beech, and coniferous forests covering about 37,000 acres.

A large part of the Frauenberg forests is managed as a game reserve and no fellings other than of dead trees are permitted: the trees are fine and the spruce portion very much resembles a Himalayan spruce forest. There are the same open spaces and the same lack of regeneration attributed to the old age of the trees and to the damage done by game, which is abundant and strictly preserved. Fallow deer, roe deer and pig are plentiful and tame and it seemed strange to be able to approach within a few yards of a savage looking wild boar.

The remainder of the Frauenberg Estate was formerly managed with the object of producing pure stands of either spruce or oak; but for many years past the object of the management has been to obtain mixed woods in order to avoid deterioration of the soil, to render the woods storm firm and to avoid insect and fungus attacks. Clear cutting and planting have been abandoned and various so-called "systems" of regenerating woods are employed, all based on natural regeneration: the exact method, whether group, combined strip and group system, etc., varies according to the conditions of the particular crop, advance growth is retained and the method is elastic whilst the resulting young regeneration is as good and as dense as can be desired.

In broad-leaved forests species other than oak come in naturally; the oak is sown or planted and favoured in early thinnings repeated every five years. Pure spruce woods are opened out in gaps wherein beech is planted before regeneration fellings really commence in order to give a proportion of beech in the next spruce crops.

The Prince's officers realised some 50 or 60 years ago that pure woods were unsatisfactory and made most interesting experiments of mixing species by alternating single lines or series of lines: owing to the varying rates of growth of all species and consequent overshading the mixtures by lines have failed to give good results, and now mixtures are obtained by making regeneration fellings under a shelterwood, sowing broadcast or planting species such as oak, and allowing other species, particularly beech, to come in naturally, the mixture being regulated by early and judicious thinnings.

THE BOHEMIAN FORESTS.

The vast Bohemian Forests are situated on the Bavarian border, the country consisting of rolling hills with long ridges, the highest ridge forming the political boundary between Czechoslovakia and Bavaria. The altitude varies from 2,150 to 4,200 feet, a very large proportion of the woods lying at over 3,600 feet. The slopes vary from about 5 per cent to 30 per cent and average about 10 per cent. The country is well watered by small brooks and rivers forming the catchment area of the river Moldau, a sluggish stream with marshy banks.

The rainfall is high: snow in winter often reaches a depth of nine to ten feet and lasts from November till the beginning of May. The spring is very short and in summer thunderstorms and high winds are frequent. The locality is especially well suited to spruce and silver fir; the beech also grows well and all have full seed years every six or seven years with partial seed years at intervals.

Frequent south-westerly and north-westerly gales have repeatedly done much damage in the past, to an extent which has frequently necessitated the suspension of all ordinary prescribed fellings in favour of the extensive exploitation of large tracts of forest devastated by storms. In 1870 many *million* cubic feet of timber were thrown by wind in the Blockenstein Komplex alone.

The underlying rocks are granite and gneiss of the geologically well known Bohemian Horst: the soil is a deep fresh sandy loam especially suitable for tree growth except in badly drained moors and bogs lying at a high altitude.

Spruce is the predominant species forming over 75 per cent of the crop; beech under 10 per cent; silver fir 6 per cent and Scotch pine 2 per cent with some maple, ash and elm. The mountain pine (*Pinus montana*) occurs over large areas on the high lying moors, where also the mountain ash (rowan) and birch are often found, but these species are of no sylvicultural or economic importance.

SYLVICULTURAL SYSTEMS.

A.—*Clear Felling.*—Up to sixty years ago (1864) it was customary to form pure spruce woods when the old mixed crops

were cut over in clear fellings, but during the last sixty years the aim of the management has been to obtain mixed crops with an admixture of beech up to 30 or 40 per cent of the whole for the following three main reasons :—

(1) The productivity of the ground under a system of clear cutting followed by planting of pure spruce has undoubtedly fallen. The yields of the old mixed crops for many generations are known as old working plans records are in existence and date back to 1780, and it is found that there has been an undoubted drop in the productivity of the soil: the yield has fallen by about 20 per cent from 7,800 to 6,300 cubic feet per acre.

(2) The damage done by wind in pure crops is very great indeed: even so lately as 1917 and 1922 hundreds of acres of pure spruce woods were laid flat by the wind.

(3) There is an ever present danger of insect attack.

Clear felling followed by planting is now resorted to only when paucity of seed years renders it impossible to execute sufficient regeneration fellings. Wind breaks are planted up with spruce.

B.—*Selection Fellings.*—A few hundred acres at the highest altitudes, where snow lies very deep in winter and undergrowth of fern, bilberry, etc., is very dense are managed under the selection system, such woods being maintained for protective purposes.

C.—*Regeneration Fellings.*—Attempts are always made to regenerate the woods naturally and only on the high lying moors and in pure spruce crops is clear felling followed by planting resorted to.

The method of natural regeneration under a shelterwood is used and the so-called "system" is adapted to the particular condition of the forest to be regenerated: forests are examined and mapped in great detail and age classes separately delimited by the Working Plans Officer, who prescribes the system under which fellings in each sub-compartment are to be made: the majority of the fellings are on the group system, generally combined with strip fellings; Wagner's strip system is occasionally

4. Logs at Salnau railway station, sale depôt on Schwarzenberg Canal.

5. Natural regeneration obtained under group fellings. Böhmerwald mixed spruce, silver-fir and beech.

6. Combined strip and group felling, Ernsthausen. Böhmerwald spruce, silver-fir and beech, natural regeneration.

employed but is only rarely applicable owing to the configuration of the forests : the uniform shelterwood compartment system has been abandoned as not being suited to the spruce in this locality, which was to be expected in view of the prevalence of wind break.

The aim of the foresters is to follow nature : advance growth is retained wherever practicable and is used as a nucleus from which further fellings are extended. It is interesting to an Indian Forester to note the way in which European foresters are adopting the slogan "Follow nature and don't force the forests to conform to a theoretical system but adapt the system to the forests," which was understood in India years ago and from which we have perhaps shown some tendency to depart in some of our recent working plans. Mr. F. C. Ford Robertson has made some interesting remarks in the October 1924 number of the "Indian Forester" on the change in attitude of the German forester, and it only remains to say here that in Czechoslovakia and Austria the position was realised more than a decade ago when the worship of the fetish "system" was abandoned. It is not possible to count on a seed year more frequently than once in ten years and a long regeneration period is necessitated.

The rotation is nominally 110 years but depends on the productivity of the soil which in some localities will produce trees of the desired size in 100 years whilst on poor ground trees of marketable dimensions are not produced under 120 to 140 years. The estate is well cut up by roads rendering extraction easy, and, consequently elasticity in sylvicultural method is possible with wonderfully satisfactory results.

THE SCHWARZENBERG CHANNEL.

A very large part of the Bohmerwald was formerly inaccessible and remote from markets and no method of cheap transport existed. In the year 1789 a small canal was commenced by Rosenaur with the object of transporting fuel from the Bohmerwald to the river Moldau and thence to the big towns.

The Zwettelbach brook was improved from its junction with the Mühl and by 1793 was ready up to the Hirschberg ; by 1821

the successors of Rosenaur had tunnelled through the Hirschberg Mountain.

The channel is 32 miles long with an average gradient of 0·25 per cent, is about 5 feet wide and 2 feet deep and floored with rock. Water is introduced from the numerous streams traversed by the channel and a dam and pond at the source are used for flooding. Many tributaries have been built, and as the channel crosses the main Central European Watershed a branch channel has been taken to streams leading to the Danube.

As the demand for timber increased curves were straightened and the channel now transports logs up to 60 feet in length and 2′ 6″ butt diameter. Before the advent of railways firewood and timber could be delivered either into the Danube or the Elbe, but nowadays the main railways cross the channel and timber is delivered by rail to the largest towns of Central Europe. The cost of transport is very low indeed and the channel has paid for its cost of construction over and over again and is of the greatest economic importance.

The construction of the channel first rendered the Bohmerwald a valuable possession, and the then reigning Prince Schwarzenberg realised that definite plans of management for the exploitation of his forests would be necessary and caused what are some of the first Working Plans in Europe to be drawn up.

UHRWALD.

At Kubany Bohmerwald, several hundred acres have been preserved as virgin spruce and silver fir forest, some of the trees being particularly fine, spruce reaching a height of 160 feet and 525 cubic feet in volume.

This is the only area of virgin forest left in Europe west of the Carpathians and almost exactly resembles the virgin spruce and fir forests of the Sutlej Valley.

We visited the Sales depôt at the Salnau Railway Station which is traversed by a water channel parallel to the railway, thus facilitating the cost of handling the firewood and timber in depôt.

A celulose and paper factory with subsidiary sawmills at Kummau was visited, using 10,000 H. P. electrical power, 3,000 H. P. steam power and employing 1,500 workmen. Two processes are used; chemical (sulphite) for all fine grades of paper, with a special sulphuric acid plant and tower; and mechanical for cardboard: fifty per cent of its produce is exported, largely to England.

The Styrian Alpine Forests.

Central European foresters are endeavouring to evolve a system of felling and regenerating cheaply forests on steep hill sides: as these forests are generally remote from centres of consumption and extraction costs are heavy, fellings have to be as concentrated as possible and extraction must be in the form of log and directly down hill, otherwise the costs of extraction are too heavy to allow of timber being sold at a profit.

In former years private owners and Government made most extensive clear fellings followed by planting even on the steepest hill sides: coupes were planted up at once mainly with spruce but owing to the deterioration of the soil and to exposure the growth on these clear felled areas was very slow indeed, and throughout Austria one sees areas on which the young plants have not closed up even after thirty years, whilst the height growth is miserable. In some localities shelterwood compartment fellings are made over a few acres with satisfactory results, but prevailing opinion is against the shelterwood system over extensive areas.

Near Stadl in Styria, Frohnleiten and Semmering on private estates and near Reute in the Tyrol Government Forests vertical strips are being experimented with, and the various forest officers informed the writer that prevailing opinion in Central Europe was that this method allowed of the most advantageous compromise between sylvicultural necessities and limitations of cost of extraction.

The best examples were seen at Stadl where the slopes are moderate to steep, the forests extend from 3,000 feet to the highest limits of tree growth and the main species are spruce and

larch, the proportion of the latter increasing as altitude increases The forests are well cut up by sledge roads and the forest is fairly well divided into compartments rendering it possible to arrange for a number of felling series. Strips run vertically the whole depth of the compartment and are about 75 feet broad, roughly the height of the neighbouring trees, but may be as broad as one and half times the height of the trees.

The spruce is clear-felled and the larch is left standing : in advance of the strip seeding fellings are sometimes made. The strip is planted up at once with spruce and copious regeneration of larch is obtained naturally, with a very few natural spruce seedlings. The young plants in the areas seen appeared to receive sufficient side shelter and were flourishing.

To an Indian forester the method appears drastic but might be tried in the outer Himalayan coniferous forests on fairly steep eastern and northern slopes where insolation is not to be feared : many of the localities visited were as steep as the ordinary run of hill sides in Kulu and Lower Bashahr.

WORKING PLANS.

As already noted there is a strongly staffed Working Plans branch responsible directly to the General Forest Director for the compilation and revision of working plans and for the check and control of operations both in the forest and in the office. Working plans are made for every Revier and are revised at intervals of ten years.

The yield is fixed by area after an elaborate volume check and comparison with the normal yield, and is based not on formulæ, which now appear generally discredited in Central Europe, but on actual calculations of the standing volume of crops older than the half of the rotation averages and yield tables. Increment during the ten years period between revisions is not taken into account; consequently the yield is always conservatively assessed and is slightly below the maximum permissible.

The forests are not divided into periodic blocks, as the danger of windbreak and the irregularity of seed years are sufficient to

render this procedure useless. Sylvicultural considerations and the progress of natural regeneration are the prime factors in determining future fellings. Dr. Heske is about to publish a monograph on the various methods in use in Europe for calculating yields and it is unnecessary to describe this method in detail here. Of particular interest are the model relief maps of the whole forest estate maintained at headquarters, which are of much use to Working Plans Officers when formulating their proposals. Similar maps would be of great value in India but the cost and labour involved in their preparation are great.

THE MYELHOF ESTATE.

This estate is of particular interest as illustrating the connection between industrialism and forest management, and shows the way in which the conception has gradually developed that only by correct sylviculture can the best financial results be obtained.

History.—The owner, Baron Myelhof, comes of an industrial family which came into prominence about four generations ago when it possessed a small acreage of woods near Frohnleiten in Styria, these woods being used to produce charcoal for iron smelting. Neighbouring estates were purchased and the forests now cover 90,000 acres.

In order to produce charcoal the woods were cut over in clear fellings and were replanted with spruce, several seedlings being planted together in order to produce the maximum amount of small timber suitable for charcoal burning. With the closure of the steel furnaces about forty years ago systematic forest management commenced and working plans were made with the object of growing timber instead of fuel. The owners, being big industrialists, needed capital for industrial undertakings and frequently raised money for industrial developments by cutting down timber: as soon, however, as the money market became easier the clear cuttings were replanted and throughout the history of this estate forest finance has been intimately connected with the financing of large industrial undertakings. Clear cutting was abandoned at the close of the War and nowadays every effort is made to obtain natural regeneration.

Accounts.—A special system of forest book-keeping, based on the double entry system, has been developed and allows of a fortnightly review of accounts showing how the capital is being utilised; in the office are only five accounts clerks: owing to the numerous banks in the neighbourhood all payments are made by cheque by the head office.

Working Plans.—During the War working plan revisions were suspended but now are again being taken in hand. Plans are revised every ten years when the yield is assessed for the following ten years: annual variations are allowed subject to a minimum outturn. The yield is assessed by volume with an area check based on the comparison of the area occupied by the various age-classes with the normal age class.

The forests consist largely of spruce and silver fir with an admixture of larch and beech managed on a hundred year rotation.

Most of the forests are on very steep ground comparable with the outer Himalayas. The management endeavours to obtain mixed woods by natural regeneration: the shelterwood system is largely used but shelterwood fellings over a large area are not popular with the management owing to their speculative nature: vertical strip fellings on the steepest hill sides are being tried.

It is considered that it will be impossible to regenerate naturally high lying woods above 3,700 feet in altitude: narrow vertical strips are being cut and will be planted up if natural regeneration does not occur.

Exploitation.—It is proposed to spend annually during the next few years £10,000 on developing the means of transport. In addition to four kilometers of ropeways, 60 kilometers of railway will be constructed of gauge 760 m.m., costing at current rates of exchange £1,000 a mile inclusive of engines, material and construction charges.

A modern paper mill is in operation at Frohnleiten operated by hydro-electric and steam power.

A sawmill with modern machinery and appliances is approaching completion and already consignments of sawn timber

have been sent to the Argentine. I was most interested in a consignment of spruce planking, cut to exact specification and of specially good quality being sent to New York against a firm order. One would have thought that to send timber to America from Central Europe would be like sending coals to Newcastle: this, I believe, is the first deal timber to be sent from Europe to America and shows how the forests of the Eastern United States have been depleted.

Sawmills in Central Europe have been largely remodelled since the War and equipped with machinery on the Swedish and Finnish pattern, and always allow for facility of handling combined with the avoidance of waste in conversion.

This article has already extended to an undue length and no description will now be attempted of the Government forests visited, where, however, the methods of extraction are most interesting, varying from primitive but financially profitable log slides to the most recent aerial ropeways, all designed, however, to bring timber to market in the best condition at the lowest cost.

Dr. Heske very kindly allowed me to say that any Forest Officer on leave from India would be welcomed at Vienna: he hopes to institute a series of post-graduate tours in Central Europe, and this year is, I believe, taking Professor Troup and the Oxford students through some of the forests described above.

H. M. GLOVER, I.F.S.

THE BURMA SELECTION SYSTEM.

The Selection System requires much less expenditure than any other system, and as our allotment for silvicultural operations is restricted to less than a pice per acre, we are obliged to depend on this system for the management of the bulk of our reserved forests. It is depressing, therefore, to find that few of the authorities on Forestry have a kind word to say for this system and that most of them consider it applicable only to very small areas and to require exceptional skill.

Orthodox foresters, however, base their opinions almost entirely on a study of artificial forests and as our forests in Burma are natural forests I venture to suggest that we should be very

cautious in accepting their conclusions, but, on the other hand, I advocate that we should make more use of the knowledge acquired by naturalists who devote their attention exclusively to species which undergo a natural *struggle for existence. Our orthodox* brethren assumed that because fire-protection was a necessity in the artificial forests of Europe, therefore it must be highly beneficial in the natural teak forests of Burma and for some twenty-five years practically refused to admit that there was any obligation to justify expenditure on this operation. Most species, however, are intolerant of fire and the fact that in the deciduous forests of Burma all species were to some extent able to withstand fire indicated that fire had been a highly important factor in determining the distribution of species and a knowledge of natural history would, therefore, have warned us that fire-protection was a dangerous experiment and one calculated to disturb the balance of Nature. The introduction of fire-protection was regarded as the dawn of Scientific Forestry, but this operation has not come up to expectations and the moral is obvious.

I understand that the Selection System is condemned on the grounds that in an irregularly aged forest it is extremely difficult to ensure normal regeneration and normal age gradations. I do not deny that in an artificial forest where regeneration is dependent on an artificial opening of the canopy it must be extremely *difficult to ensure normal regeneration, but we are only concerned* with truly natural regeneration and I understand from naturalists that the regeneration of a species which is undergoing a natural struggle for existence must be what we call normal. Every species produces vast quantities of seed and may be said to be striving its utmost to increase its numbers at the expense of its competitors, and any species which failed to produce sufficient seed and regeneration to maintain its numbers would therefore rapidly become extinct. We know, however, that teak must have held its own against all competitors for some thousands of years, and although we may be quite ignorant of the amount of regeneration required, we may be quite sure that on an average exactly the right amount of regeneration must be effected naturally in order to maintain the growing stock.

A normal forest means a forest in which the age classes are graduated in such a manner as to ensure a regular and sustained yield, but artificial forests are assumed to be abnormal and in Europe it is, I believe, the practice to attempt to make them normal by means of thinnings. Our orthodox brethren seem, however, unable to agree among themselves what the correct proportions in the different age classes should be, and as it is an extraordinarily difficult operation to regulate the age gradations by means of thinnings, it is inevitable that they should be strongly prejudiced against the Selection System. Natural history, however, teaches us that the age gradations of a species which is undergoing a natural struggle for existence must be normal. When one visits a country after a lapse of years one finds little change in the population. There appears to be the same number of aged people, the same number of lovers wandering down the lanes at twilight and the same number of babes and young children, and so throughout Nature, although individuals pass away or pass into older age gradations, the age gradations remain practically unchanged. We take it as a matter of course, but nevertheless it is truly wonderful, that permanent school buildings can be constructed of the right size to accommodate not only existing children but children yet unborn, that calculations in respect of barracks and equipment can be made on the assumption of a regular and sustained supply of conscripts, and that in the case of old age pensions it can be calculated that the amounts to be paid out from the Treasury will fluctuate little from year to year. Natural history teaches us that such calculations can be made because mankind is waging an incessant struggle for existence against famine, disease and accident, and as a species such as teak also undergoes a severe struggle for existence, surely it must be perfectly obvious to any unprejudiced person that the age gradations of teak must also be normal.

It was, I think, either Lubbock or Darwin who described how certain insects will instinctively continue to do certain acts even when their environment has been changed so that the necessity for such acts does not arise, and to my mind it is equally pathetic to observe how industriously our orthodox brethren collect statistics

regarding the number of teak poles and saplings. Having at great expense collected such statistics, they seemed for many years at a loss to know what to do with them and were accustomed to bury them reverently in their working plans, but recently they have adopted the practice of utilising them for purposes of control. We are only interested intrees which attain a girth of seven feet, but Nature is less exacting and seems to go out of its way to establish large numbers of teak poles and saplings on dry ridges and shallow soils where few can attain marketable dimensions. Even on richer soils the mortality is so great that the chances against any particular sapling surviving to maturity must be very great, and therefore although I recognise the necessity of enumerating all age classes in a fully stocked artificial forest, it seems to me absurd to believe that in Burma any useful calculation of the yield of mature trees can be based on the increment of poles and saplings.

I have moreover endeavoured to test the accuracy of these statistics and in one working circle compared the actual number of trees six feet in girth and over found by girdling officers in sample plots, with the number recorded in the working plan, and ascertained that although the figures for one sample plot were fairly accurate, those for the remaining two or three sample plots in a compartment were invariably far too low. It was evident that the working plans officer had made a habit of checking only one sample plot a day and that the enumerators in the other sample plots had taken the opportunity of scamping their work. In this particular case the statistics were utilised only for the purpose of determining the distribution of teak and were sufficiently accurate for that purpose, but the actual yield was about 30 per cent. more than the estimate, and had the yield been restricted to the estimate it would have caused an annual loss of a lakh of rupees.

A minimum girth limit effectually prevents any encroachment on forest capital and to my mind it is superfluous therefore to impose any further method of control. It seems to me, however, that the "basal area check" has concentrated attention too exclusively on volume, and that as immature trees have small

basal areas it has encouraged the girdling of such trees and thereby caused an encroachment on forest capital. There may be no connection but I think there is no disputing the fact that since the introduction of the basal area check there has been a serious deterioration in the standard of girdling.

It is not practicable to go annually over a forest and to girdle every tree as it attains maturity, and therefore even if a forest is perfectly normal it is necessary to determine how the growing stock is distributed throughout the forest. The practice is to divide a forest into compartments and having by means of enumerations made an estimate of the growing stock in each compartment to group a number of compartments together into coupes each of which is estimated to contain an equal proportion of the growing stock. The process is quite simple, but there are one or two points in connection with the distribution on which I wish to express my view.

A struggle for existence seems invariably to result in a state of stability. In the Highlands of Scotland the population has always been small as compared with that in regions where coal fields exist or where the conditions are favourable to commerce, but although man can migrate freely from one country to another or from the country to the town, I believe each successive census reveals remarkably little change in the relative distribution of population. Similarly teak of large size is scarce on soils such as laterite or stiff clays and is more numerous where the conditions are naturally favourable, and as its prevalence or scarcity is ultimately dependent on the soil and climate which do not change, we may, I think, assume that its distribution throughout a forest will remain unchanged.

If this assumption is justified, it follows that it is quite superfluous to make fresh enumerations at the beginning of each period. The compartments must be gone over in practically the same order and if the compartments have been grouped together so that each coupe yields approximately the same quantity of timber there can be no necessity for revising the coupes. Errors however sometimes occur owing to the fact that enumerations are

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only made over 20 per cent of the area, but subsequently girdling officers go over every acre of every compartment and make a record of all mature trees and I would suggest therefore that these statistics should be utilised for the purpose of correcting any mistakes in the original estimates.

In some of the older working plans attempts were made to calculate the number of immature trees which would attain maturity and the number of mature trees which would die during the currency of a plan. For instance, if in a compartment there were at the time of enumeration 500 trees six feet in girth and 700 trees seven feet in girth and over, it is obvious that if the *compartment were due for girdling* in the thirtieth year of the plan, most of the six feet trees would have attained maturity, and it is not unnatural to assume that few of the mature trees would have perished. It cannot be assumed, however, that the stock of mature teak trees can increase at such a rate that if girdling were postponed for any great length of time other species would be ousted, leaving a pure crop of mature teak trees, and for practical purposes the simple rule may be laid down that the number of immature teak trees which attain maturity in any given period is exactly counterbalanced by the casualties of mature trees.

It is necessary to give girdling officers considerable discretion but some girdling officers seize the slightest pretext for girdling undersized trees, and as erratic girdling is calculated to cause fluctuations in the yield in subsequent periods I would emphasise the importance of insisting on a more uniform standard of girdling. When a plan comes up for revision it is possible to counteract the eccentricities of girdling officers by altering the coupes, but unless great irregularities would be caused I would deprecate much alteration of the coupes for this purpose.

When enumerations are made I maintain that the rule should be to prescribe a minimum girth, and having determined the distribution of the growing stock to regulate the yield by area without any restriction as to the number of trees to be girdled, but when the value of the crop is insufficient to justify enumerations I think the rule should be to prescribe the number of trees to be girdled annually, without any restriction regarding the

area to be gone over, beyond prescribing the order in which the compartments should be gone over. A number should be prescribed which will ensure the whole forest being gone over in a period of not less than 20 years or more than 40 years and as one forest can be compared with another and local information utilised it is not so difficult as might be supposed to make a fairly reliable estimate, and it is always possible to alter the number if there is reason to believe that it is too high or too low. For instance, supposing that the yield were fixed at 2,000 first class trees and that at the end of the first ten years it was found that half the area had been gone over and that the range officer reported that the remaining area was not appreciably richer in teak than the area already gone over, the yield could be reduced to 1,500 trees a year. So long as a forest is gone over within a period of not less than 20 years or more than 40 years the period is not of great importance, but by definitely prescribing the number of trees to be girdled annually a regular yield and revenue is assured for a number of years, and when the whole forest has been gone over, the girdling records provide accurate and reliable data concerning the distribution of the growing stock which makes it possible to draw up as detailed a working plan as may be desired.

I have suggested that our teak forests are normal and that so long as we do not disturb the balance of nature we can rely on a sustained yield, but we have to take into account the fact that the girdling of a proportion of the seed-bearers does to some extent disturb the balance of nature. The proportion of teak seldom comprises more than 5 per cent of the total vegetation and therefore it is incumbent upon us not only to maintain the yield but also to ensure a steadily increasing yield. Moreover, although we are fortunate in finding a large surplus of overmature trees which practically doubles the normal yield during the first two periods, we have to anticipate a serious diminution of the yield at the beginning of the third period—in fact just about the time when a mere layman would expect some return for the large sums of money which we are now spending. A serious reduction of the outturn generally entails very serious

consequences and I would therefore particularly urge the importance of taking steps to prevent such a contingency.

The solution of these difficulties seems to me to be quite simple, but requires a clear understanding of what is meant by "the natural rate of increase." The elephant is believed to be the slowest breeder of all species and in order to illustrate how rapidly all species tend to increase Darwin estimated its natural rate of increase and calculated that after a period of 750 years there would be nearly 19,000,000 elephants alive descended from the first pair. For our purposes, however, it is more instructive to study the statistics collected for working plans purposes and I have, therefore, prepared a list showing the proportion of trees in each age class based on the enumeration of a large number of trees and the rates of mortality based on the assumption that the age gradations are normal.

Girth Class.	Relative number of trees.	Natural rate of mortality.
8 feet in girth and over	4,000	...
7 feet	3,000	...
6 feet	5,000	2,000
5 feet	9,000	4,000
4 feet	14,000	5,000
3 feet	21,000	7,000
Total over 3 feet ...	56,000	18,000
Under 3 feet ...	183,000	142,000

As a natural forest is fully stocked the rate of increase must be exactly counterbalanced by mortality and on the assumption that every tree above three feet in girth may be considered a seed-bearer, it follows that while some 5,000 out of 56,000 seed-bearers

might be girdled for purposes of revenue, a further 18,000 seed-bearers would be destroyed by natural causes. On an estate in England when the game is not preserved it is naturally so scarce that it is hardly worth while taking out a game license, but as Darwin pointed out, when the natural mortality is reduced by destroying vermin and where the conditions are favourable immense numbers of partridges, grouse and hares can be killed annually without prejudice to the growing stock. Similarly, although teak can be grown artificially in almost any part of Burma, it is naturally so scarce that the search for mature trees is a wearisome business, but if the growing stock were scientifically preserved by reducing the natural mortality it could be proved mathematically that the growing stock could be increased to such an extent that it would be possible to ensure a greatly increased outturn.

The principal cause of natural mortality is lack of room for development. We regard a plantation as fully stocked when it contains 1,200 seedlings per acre, but although the seedlings are perfectly healthy we know that by the time they reach the sapling stage they must be reduced to about 120 and that of these only some 30 can survive to maturity. Similarly we know that as every acre of natural forest is fully stocked each generation of natural seedlings must be naturally thinned out and that only a small proportion can survive to maturity. It is evident, however, that as the stock of teak is scattered throughout the forest and only forms a small proportion of the vegetation, this mortality can be reduced by giving suppressed trees the room they require for development. Vegetation in these forests is, however, so luxuriant that it obviously is not worth while to assist mere seedlings and I have always regarded Y fellings as a waste of money, but if we went systematically over our forests and searched for suppressed teak stems in the same way that we search for mature teak trees, we should find many a promising sapling and young tree which at the cost of a few annas could be saved from a lingering death. The natural rate of increase is, however, at first very slow, but it must be borne in mind that when a tree is given adequate room for development, the rate of growth is greatly accelerated.

Experience in plantations proves that the potential rate of growth is twice as fast as that of natural teak which undergoes a struggle for existence, and assuming that a teak tree is worth about Rs. 20 at maturity, I have no doubt that it could be proved that we should be justified in spending several rupees on giving each natural sapling or young tree adequate room for development.

Our orthodox brethren unfortunately have little use for systematic improvement fellings. They seem to disapprove of our vast and poorly stocked jungles, and being accustomed to what may be called kitchen garden forestry never seem quite happy unless they are laying out neat little beds of even aged plants. They do not hesitate to spend money on plantations and would, I think, be quite prepared to incur a deficit on converting a forest into the uniform system, but I doubt whether in any forest managed under the Selection System as much as five per cent of the revenue is devoted to increasing the yield. Our orthodox brethren may despise the Selection System. They may prove to their own satisfaction that it is crude and unscientific, but the fact remains that the income derived from the forests in Burma which are managed under this system is very large and reasonably regular and that without this income funds would not be available for forestry, orthodox or otherwise.

SCEPTIC.

THE BURMA SELECTION SYSTEM.

[A REPLY TO THE FOREGOING ARTICLE.]

I think "Sceptic" has completely missed the whole point in his article. In Burma, although we may have gone rather too far in our enthusiasm for wholesale clearfelling and regeneration no great harm has been done and we have now returned to more moderate views. There is no question that for a very large area of our forests the selection system is and must remain the most suitable system. At the same time there can be little question that the selection system as carried out in Burma is entirely different to the selection system as carried out in Europe. There can be no comparison between the fully stocked unevenaged

forest such as would be managed under the selection system in Europe and the very poorly stocked mixed forest with the crop mainly consisting of bamboos or valueless species such as exists under the present conditions in Burma. I do not think "Sceptic" can possibly say that the forests managed under the selection system in Burma are bearing their full economical yield. This is the essential point in our conversion of the selection system to the uniform system. It is desirable to increase the capital value and therefore the yield in such areas as we can conveniently concentrate on, more especially, in such areas where communications can be laid out in order to extract the produce at a reasonable cost. The selection system as carried out in Burma was undoubtedly the only possible system under the conditions when Brandis first started Forest Management.

As time went on and the demand grew greater intensive methods were inevitable. The intensive selection system as carried out in Europe is in *densely stocked unevenaged forests* and of such we have not a single case in Burma. Some other more suitable method of intensive working is therefore essential and owing to the small number of seed-bearers per unit of area it is impossible to rely on any form of natural reproduction in order to procure a densely stocked wood. Hence the "Kitchen garden" which "Sceptic" intends to be so insulting to those he calls "orthodox foresters."

"Sceptic's" ideas of the normal forest seem to be very vague. He argues that a natural forest is always a normal forest because natural selection ensures a normal series of age gradations and a normal survival of regeneration. It is perhaps as well to turn to Schlich's definition of a normal forest. He says a normal state of forest depends chiefly on the presence in it of—

(1) A normal increment.

(2) A normal distribution of the age classes.

(3) A normal growing stock.

He says also that by normal increment is understood that which is possible, given a certain locality, species, and rotation. Surely no one would argue that the Burma teak forests are giving anything like the normal or possible increment. For one thing

we know definitely that, apart from the poor stocking of a Burma teak forest, it is possible to grow teak very much more rapidly in evenaged woods. Natural laws do not affect the fact that a greater portion of our forests have only 15·8 trees of all species over 3′ girth per acre, of which only 2·27 trees are teak (estimates for whole of Pegu Yomas from Mr. Watson's Pegu Yoma note) and that most of these forests are too unaccessible to extract anything except teak. Moreover how many of our forests can be considered natural forests? The natural laws quoted by "Sceptic" surely can only apply when there is no outside influence affecting them. In our forests we are removing trees of only one of many species long before they become naturally mature and die and this must tend to upset the natural proportion of this species not only by removing all the older trees but also owing to the removal of a large proportion of the best seed-bearers by reducing the amount of seed available and thus reducing the regeneration. This we attempt to correct by improvement fellings but surely these only further interrupt the natural sequence and interfere with the natural rules.

I take very considerable exception to "Sceptic's" statement that the "basal area check" has concentrated attention too exclusively on volume and that as immature trees have small basal areas it has encouraged the girdling of such trees and thereby caused encroachment on the forest capital. On the contrary, since the basal area control was introduced in 1921 there has undoubtedly been very considerable improvement in the standard of girdlings as, with the more efficient method of control carried out in conjunction with the basal area control, it has been possible to take a wider point of view and to scrutinise the figures for the girdlings in the different forests of the Province. It was only then that it was discovered that the girdling rules had been ignored in many cases, a serious state of affairs due to lack of supervision in the years following the War when we were short of officers. After all, the basal area check is only adopted to prevent over-felling and the girth limit is still the primary control. Moreover the basal area control is exercised entirely by increasing the girth limit when there is a danger of excess girdlings. There are no

doubt, objections to the basal area control and it is possible that this control is not altogether necessary in forests managed entirely under the selection system, but some sort of volume control is essential in forests which are managed under the clearfelling system where selection fellings are necessary in all areas other than the first periodic block. Tree control, where the trees below the ordinary exploitable girth have in many cases to be removed in the regeneration block, becomes an impossibility.

I entirely disagree with "Sceptic's" assumption that all forests are in a more or less normal state. He says that if the compartments have been grouped together so that each coupe yields approximately the same quantity of timber in the first period, there can be no necessity hereafter for revising the coupes. He entirely ignores the fact that the forests we are now managing have in the past been affected by various conditions such as *taungya* cutting, over-extraction and unregulated fellings which have caused them to depart from any semblance to a normal forest. It is, therefore, essential that fairly frequently re-enumerations should be made in order to arrange for an equalised annual or sub-periodic yield as well as to note the results of our treatment on the growing stock. "Sceptic" would be prepared apparently to work a forest entirely without enumerations. I should have thought that the failure of the old girdling schemes to lay down annual coupes giving an equal yield would have disabused him of the idea that this is in any way possible.

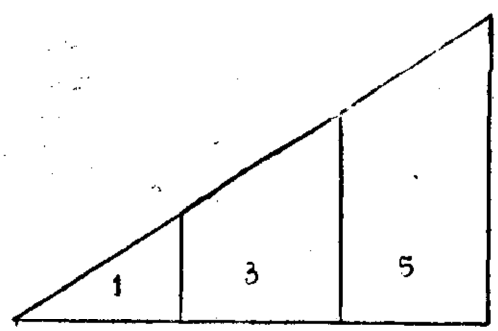
"Sceptic" is certainly an improvement on the wicked and slothful servant who hid his talent in the earth. He is willing indeed to take the ordinary usury on his capital but he is still far removed from the good and faithful servant who doubled his capital. Progress in forestry aims above all things at the improvement of the capital value of the forests. Nature has given us vast forests of great potential but of little actual value. In the belief that by concentration of effort we can increase the value of those forests, I subscribe myself.

"A KITCHEN GARDENER."

4

THE FRENCH 1883 METHOD. A GENERALISED MODIFICATION.

This method is too well known to Indian foresters to require any elaborate or detailed explanation. Put very briefly, the method as applied to selection forests is as follows :—The forest is enumerated in diameter classes, the rotation fixed and the diameter of a tree of rotation age determined. Then the growing stock is divided into 3 classes :—(1) old wood, 67 per cent and over of rotation age, (2) average wood, 34 per cent to 66 per cent of rotation age and (3) young wood, up to 33 per cent of rotation age (These latter usually not being enumerated.) For a normal forest, these three classes should show the volume ratio of 1 : 3 : 5.



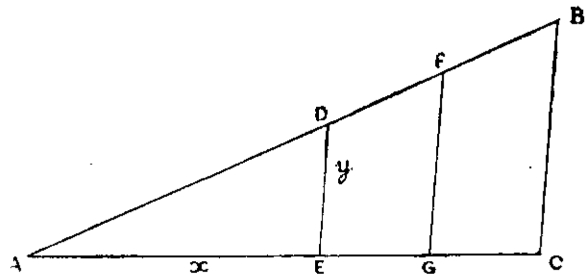
If there is a normal (or nearly normal) proportion between old and average wood (*i.e.*, 5 : 3), the annual yield is fixed at the volume of the old wood divided by 1/3 of the rotation, plus its increment during half that period. If the proportion of old and average wood is distinctly abnormal, necessary adjustment has to be made, *e.g.*, if the proportion was 6 : 3 sufficient of the old wood would (subject to the predominant claims of silviculture) be transferred to the average wood, or if 4 : 4 *vice-versâ.* It is unnecessary to explain the method further, since it is fully dealt with in all text-books. But in its practical application, there is one difficulty, namely the enumeration of the crop down to 1/3 rotation age. If this is logically followed, it means that enumerations have to be taken to different limits for every rotation and for every quality

class. As an illustration, the following table may be given (obtained from the *sal* yield for the U. P.)

Rotation.	I Quality.		II Quality.		III Quality.	
	Rotation diameter.	1/3 rotation diameter.	Rotation diameter.	1/3 rotation diameter.	Rotation diameter	1/3 rotation diameter.
80	18·5	7·7	15·4	5·6	12·8	3·8
90	20·1	8·7	16·8	6·4	14·0	4·5
100	21·6	9·5	18·1	7·1	15·2	5·1

It is scarcely necessary to emphasise that such a jumble of enumeration limits would be a most difficult matter in actual practice, and in India, working over enormous areas with illiterate and low paid labour it would be impossible. Large scale enumeration work in the U. P. has shown that callipers have to be coloured in standard and broad diameter classes, but such variations in enumeration limits would render enumeration work on our standard lines almost impossible. But in this French 1883 method, the fixing of the unmerchantable volume at up to 1/3 of the rotation is purely arbitrary, and is a special case of a general rule. In the principal U. P. *sal* forests away from the neighbourhood of big cities and intense demand, we regard 8" diameter as the limit of unmerchantable volume, and this diameter will be (for evenaged crops, excluding establishment of seedlings) 27 or 37 or 47 years old according to quality. If therefore we can put the underlying idea or the French 1883 method into general terms, and find the proportionate volume between the three classes of wood where the young or unexploitable wood is up to any fraction of the rotation, we can then enumerate down to a standard diameter (irrespective of rotation or quality) and yet ascertain whether the proportion between the old and average wood is normal or not, and calculate the yield accordingly.

The following is an attempt to obtain the proportionate volume of the 3 age (or size) classes in general terms.



In the usual way, let **ABC** represent a normal forest,

AC = corresponding to the rotation $= r$ ·

AE = Age of unexploitable wood $= x$

(In the French 1883 method $\mathbf{x}$ of course $= 1/3\mathbf{r}$)

also let the exploitable wood be divided equally in two **parts** (**by** area or age) at **G**.

then **EG** = **GC** = of course $\frac{r-x}{2}$

Also let **DE** = an unknown **y**

Then volume of young wood = $\triangle$ ADE $= \frac{1}{2}\,\mathbf{xy}$

„ average „ = figure **DEGF**

and „ old „ = „ **FGCB**

We have to find the proportion between these three **areas**.

By similar triangles, $\mathbf{FG} = \mathbf{AG} \times \frac{y}{x} = \left(\mathbf{x} + \frac{r-x}{2}\right) \times \frac{\mathbf{y}}{\mathbf{x}} = \frac{\mathbf{y}}{2x}(\mathbf{r}+\mathbf{x})$

Similarly $\mathbf{BC} = \mathbf{AC} \times \frac{y}{x} = \frac{ry}{x}$

$\triangle\ \mathbf{AFG} = \frac{1}{2}\,\mathbf{FG} \times \mathbf{AG} = \frac{1}{2}\left[\frac{y}{2x}(r+x) \times \frac{r+x}{2}\right] = \frac{y(r+x)^2}{8x}$

$\triangle\ \mathbf{ABC} = \frac{1}{2}\,\mathbf{BCAC} = \frac{1}{2}\left(\frac{ry}{x} \times r\right) = \frac{yr^2}{2x}$

$\therefore$ figure **DEGF** = $\triangle$ **AFG** $-$ $\triangle$ **ADE**

$= \frac{y(r+x)^2}{8x} - \frac{1}{2}xy = \frac{y}{8x}(r+3x)(r-x)$

and figure **FGCB** = $\triangle$ **ABC** $-$ $\triangle$ **AFG**

$$\frac{yr^2}{2x} - \frac{y(r+x)^2}{8x} = \frac{y}{8x}(3r+x)(r-x)$$

hence the proportion we require

$$\triangle \text{ ADE : figure DEFG : figure FGCB}$$

$$= \frac{1}{2}xy : \frac{y}{8x}(r+3x)(r-x) : \frac{y}{8x}(3r+x)(r-x)$$

$$= 4x^2 : (r+3x)(r-x) : (3r+x)(r-x)$$

Here we have a simple proportion in terms of two known quantities r and x, and applicable (in reason) to all values of r and x and hence applicable to standard diameter limits for enumeration. It looks rather a formidable proportion, but it boils down to very simple figures for any simple proportions between r and x

For example.................... let $x = 1/3r$

then the proportionate volumes of the 3 size or age classes

$$4\left(\frac{r}{3}\right)^2 : \left(r+3\frac{r}{3}\right)\left(r-\frac{r}{3}\right) : \left(3r+\frac{r}{3}\right)\left(r-\frac{r}{3}\right)$$

$$= 4/9 : 4/3 : 20/9 = 1 : 3 : 5$$

which of course is the French 1883 ratio.

Again let $x = \frac{1}{2}r$

then the proportions become

$$4\left(\frac{r}{2}\right)^2 : \left(r+3\frac{r}{2}\right)\left(r-\frac{r}{2}\right) : \left(3r-\frac{r}{2}\right)\left(r-\frac{r}{2}\right)$$

$$= 1 : 5/4 : 7/4 = 4 : 5 : 7$$

Let $x = 1/5\ r$, and proportion

$$4\left(\frac{r}{5}\right)^2 : \left(r+3\frac{r}{5}\right)\left(r-\frac{r}{5}\right) : \left(3r+\frac{r}{5}\right)\left(r-\frac{r}{5}\right)$$

$$= 1 : 8 : 16$$

Draw for these values graphically to scale on sectional paper and it can easily be seen that they are correct proportions. Similarly for other values of x in terms of r.

If this is accepted as correct, it follows that we need no longer bother about enumerating and defining exploitable wood as over 1/3 rotation age, but we can enumerate down to what actually is exploitable wood in any locality, and having ascertained or determined the rotation and the age x of our enumeration limit, we can divide the enumerated growing stock into two portions and calculate the *normal* proportion between them. If

the actual forest is more or less normal, the calculation of the yield then becomes volume of old wood divided by $\frac{r-x}{2}$ years plus its increment for half that period.

If the proportion is not normal, adjustment would have to be made as in the original 1883 method.

* * * *

Woolsey in his very clear discussion of the 1883 method points out two disadvantages, one of which is "Trees must be tallied down to 1/3 rotation age." All that is claimed for the modification given above is that it removes this disadvantage, and gives a much freer hand as regards enumeration. It does not remove the necessity for the conception of a *total* volume (as compared to a ratio or proportion only).

In conclusion I would venture to point out to those foresters in India who consider the application of a little elementary mathematics to forestry is misspent energy, that the bulk of our forests in India are still selection forests, for which working plans officers have to prescribe a yield, and where (as is usual) they cannot calculate the actual increment of the forest—a very difficult operation under the best of circumstances in a selection forest—they are faced with considerable difficulty in prescribing a *volume* yield, and any efforts to simplify the problem are of some practical importance.

E. A. SMYTHIES, I.F.S.

THE SYSTEM OF SALE OF STANDING TREES.

In the United Provinces, for more than a quarter of a century, a great deal of attention has been devoted to arriving at the best system of sale of standing trees and it is hoped that some account of the conclusions arrived at up to the present may be of general interest. My own experience began in 1896 in the submontane tract which lies between the Sarda river and the Ganges and at that time sale of lots by auction on the lump sum system had recently been introduced. It replaced a system of collecting all the Government royalty at a line of export Chaukis on a fixed schedule of rates. This system was obviously

disadvantageous both to the Forest Department and to the timber trade unless it were possible to re-adjust the rates constantly to suit the conditions of the market exactly. Such adjustments would require a knowledge of market conditions outside the forests which we are even to-day very far from having acquired. Under such a system there is at all times a tendency for some rates to be too high so that export of those classes of produce would be restricted and for some rates to be too low so that the Forest Department would not get the royalty warranted by the market price.

The lump sum system which means that would-be purchasers bid a lump sum for a lot of standing trees listed according to species and girth classes, undoubtedly greatly improved the forest revenue and encouraged the timber trade. In theory the would-be purchasers were men who understood their business and were acquainted with the general quality and conditions of the lot they were bidding for and with a knowledge of sale values were able to form a fair estimate of the value of the outturn, their working expenses and the amount it would pay them to bid as Government royalty. The Government was thus enabled to get a fair share of any rise that occurred in the value of the produce owing to improved prices or improved means of export. In actual practice a drawback to the system lay in the fact that the bidders were not capable of making such business-like estimates and that owing to the very uncertain soundness of *sal* trees it is in many cases practically impossible to arrive at anything like an exact estimate of the outturn. The result was that very large profits were sometimes made by the purchasers which led to a good deal of gambling, particularly on the part of the more reckless and unbusiness-like contractors.

Large profits tended to alternate with heavy losses and it appeared that it must be better in the long run for the Government revenue and for the general prosperity of the trade that conditions should be more stable and that the chances of timber traders being ruined and dropping out of the trade should be minimised.

The advantage for the Government revenue lay in more regular annual returns and in the idea that lack of confidence must lead to bids on the whole falling below the true value.

Before proceeding to the next system it will be well to consider the reality of this drawback to the lump sum system. A tendency of the system might be to concentrate the trade in the hands of a few men with knowledge and capital and to crush any competition from newcomers and small men, because the risks rise to a maximum. At first perhaps such powerful men did not exist and the fear of gambling causing lack of confidence and consequent loss of revenue may have been justified but should the other set of conditions arise the lump sum system by its bigger risks would tend in the long run to discourage gambling rather than to encourage it and the Government's loss of revenue would then arise from too little competition instead of from too much.

The ideal conditions would undoubtedly be complete absence of doubt about the outturn and moderate bidding by a limited number of business-like traders. An excess of traders would mean that the profits would be cut too fine and good profits are essential in the timber trade because there are big risks involved apart from any uncertainty about outturn. Since then the outturn risk has not and probably cannot be eliminated from the *sal* timber trade, the solution probably lies in having a moderate number of reliable traders who would normally bid close to the expected outturn and reap small profits but who would occasionally get prizes to compensate them for the risks. The Forest Department should then not feel any discontent at lots occasionally going very cheap.

The idea mentioned above that gambling and consequent lack of confidence reduced the revenue unduly, led to another stage with the introduction of what was called 'the Monopoly and Royalty System.' It consists of a compromise between the lump sum and the payment on outturn system. A rate list is drawn up according to which royalty has to be paid at an export Chauki on all produce removed but the would-be purchaser obtains the right to work a particular lot (the monopoly) by

bidding a lump sum for that lot. The original intention was, I think, that about half the royalty should be taken at the Chauki and about half from the lump sum. Under this system then if the purchaser had based his bid on an over estimate of the quantity available his liability to pay for produce which did not exist was limited to one half. It was believed that this limitation of the gambling element would lead to an improvement in Government revenue, because the greater certainty for the purchaser would encourage him to bid more closely to the estimated value of the outturn.

For many reasons it is extremely difficult to say whether the revenue was improved; probably it was wherever there was a lack of competition. There is no doubt that when the outturn proved to be considerably more than the successful bidder anticipated, the Government got at least half the royalty on the unexpected outturn. In this way it reduced the value of the occasional prizes which would be to the good if competition was slack and prizes too numerous.

The system has certain defects in its practical application.

The rate list needs constant adjustments based on an accurate knowledge of the market which we do not possess and as the market value of *sal* for many years tended to rise continually the royalty at Chauki tended to become a smaller and smaller share of the total royalty and the system as a whole tended to relapse towards the lump sum system. Again a lot at the top of a hill coupe has a very much smaller royalty value than a lot in the same coupe at the foot of the hill so that if the royalty at Chauki was half of the total for the top lot it would perhaps be not more than 1/5th for the bottom lot. On the other hand, if the proportion of royalty at Chauki suits the more valuable lots then lots may occur where the royalty at Chauki only is more than the produce is worth and the poorer lots become unsaleable.

It was also not foreseen, I think, that the choice between the lump sum and the monopoly system means a good deal more than the best way of realising the Government royalty. *To a very considerable extent it controls the volume of the outturn*

and the class of material exported. If the purchaser has to pay 8 annas royalty at Chauki for a scantling measuring 1 c.ft volume, obviously he is not going to pay that 8 annas on a scantling which consists partly of defective timber or is below measurements owing to wane. It is also difficult to fix royalty rates low enough to encourage the outturn of small or inferior timber which has a low sale value.

The upshot is that the lump sum system favours a large volume outturn a good deal of which may be of indifferent quality and small size while the monopoly system tends to favour a small outturn of a better quality and larger size. For a good many years past now it has been realised that for inferior lots the lump sum system is preferable from a revenue point of view and that the monopoly system merely prevents such lots from being worked seriously.

The high prices and easy profits which ruled towards the close of the War and just after it combined with a system of taking railway sleepers as security for instalments of revenue instead of cash, undoubtedly brought a large influx of would-be timber traders of small resources; competition became severe and before long market prices fell, causing heavy losses in some cases and poor profits in all. The tendency of the trader was to make as much capital as possible out of the losses due to over-estimated outturn which caused the department to turn its attention once more to means of limiting such losses.

Before proceeding to the next system tried, I should mention a modification of the monopoly system which was introduced about 1912. This was called the guaranteed monopoly system and consisted of stating in the auction sale notice that a given amount of timber from each lot was guaranteed and in the event of the outturn not coming up to the guarantee a portion of the monopoly bid proportionate to the shortage would be refunded.

The theoretical benefit of this guarantee was the same as that of the monopoly system itself, namely that purchasers would be encouraged to bid up to at least the value of the outturn of the lot as estimated by the Forest Department and thus revenue would not be lost owing to the fear that the actual outturn would

fall short of the estimate. For several reasons I do not think that this guarantee has had any effect on the revenue. In the first place, as already mentioned, the framing of anything like an exact estimate of outturn is an extremely difficult matter. Forest Officers were reluctant to be optimistic both because of not wishing to become involved in heavy refunds and because, notwithstanding the refund, it causes loss to purchasers to make arrangements for a much bigger outturn than they eventually obtain. If then purchasers actually bid on too low a guarantee the Government loses revenue but in actual practice it seems probable that contractors seldom bid on the guarantee but from their own ideas of the outturn. Further the guarantee involved the very difficult question " What is timber ? " As I have shown already the volume in c.ft. depends very largely on the class of timber converted ; secondly given that the usual type of conversion in a certain area is known, the only estimate which the Forest Department can make is that of the total outturn assuming that the purchaser works the area to its maximum. In many of the more distant areas in the hills it only pays purchasers to remove the better class and size of timber and they, not unnaturally, took the view that they ought to get a refund if their actual outturn fell below the guarantee. This not only led to a very difficult position for the Divisional Forest Officer but gave rise to a feeling among purchasers that the guarantee was a fraud. In some divisions, however, where only a partial exploitation was the custom, refunds were given on the difference between the actual and guaranteed outturn irrespective of potential outturn and this was found to cause contractors to restrict their outturn purposely so as to get a refund.

To take an example—

Guarantee 10,000 c.ft. monopoly Rs. 5,000.

Volume of better class timber on which purchaser could make a good profit 8,000 c.ft.

Deficit from guarantee 2,000 c.ft. = 1/5th,
Refund Rs. 1,000.

Volume of lower class timber which might be converted 3,200 c.ft. Possible profit on the same at 3 annas a c.ft = Rs. 600.

Thus the refund was more valuable to the contractor than the profit on the lower quality of timber.

It may be said then that the advantage of the guarantee lies rather in the protection that it affords to the forest department as regards compensation for losses than in any effect which it may have in improving revenue.

The subject of compensating purchasers for losses has received much consideration and it has recently been determined that the Forest Department cannot accept any responsibility for losses caused by a fall in the price of timber nor by bad arrangements on the part of a purchaser but it always has been felt that a certain moral obligation exists to consider losses caused by a shortage in the estimated outturn whether that estimate is guaranteed or whether it is not. If then the department announces a guarantee of a certain outturn in the auction sale notice its subsequent liability is limited.

To return to the question of reducing losses caused by over-estimates of outturn.

The obvious thing was to examine the possibilities of reversion to the original system of payment on outturn only and I was much interested to observe that an article by Mr. Hakim-ud-din of the U. P. Provincial Forest Service advocating such a system appeared in the *Indian Forester* of October 1923. Previous to the appearance of this article a special opportunity arose of testing a payment on outturn system of sale under the special conditions which existed when exploiting the forests of the Sarda valley. These forests were accessible only by the Forest Department's tramway and that could be kept open for one season only. It was essential to select reliable contractors who would not fail to complete the conversion. Therefore an auction was impossible and there was no point in collecting any part of the revenue by lump sum. A rate list was determined by mutual arrangement with selected contractors and served its purpose well enough for a single season.

In 1924-25 this system was pushed a stage further by putting up lots to auction. The method followed was based on the fact that the greater portion of the timber was expected to be of the class which would pay 8 annas royalty at Chauki under the mono-poly system. In the rate list there were several lower rates and higher rates at 2 annas, 4 annas, 6 annas and 8 annas more.

The bidding was on the 8 anna class of material. Then if the successful bidder bid say 14 annas for that class of material, the rate for all inferior classes remained the same as under the Monopoly System and the rate for all superior classes was the same 2 annas, 4 annas, 6 annas and 8 annas more than the bid It was apparent before the system was tried that the particular drawback to it is that if the bidding results in the profit on the greater part of the timber being very small, there will be a tendency to reduce the outturn of the medium class of timber and to concentrate on the cream of the timber which gives high profits on small volume. There would also be a tendency to resist altogether the exploiting of any piece of timber of poor quality which would have to pay the same royalty on account of its dimensions as a piece of good quality. A typical example is a sleeper which is likely to be rejected.

The agreement indeed contained a clause that fines could be imposed for incomplete exploitation but such clauses are notoriously hard to enforce and can only lead to a great deal of ill-feeling between the department and its purchasers. The actual result of a trial of this system may be said to be that it was unfavourable to Government interests on account of reduced outturn and that it was unpopular with contractors because the profits although fairly secure, can only be small and as already said small profits with no chance of any prizes are very bad for the trade. The very freedom from risk which the system entails causes the system to fail under present conditions. The security causes the competition to be great and to raise the bids unduly and thus to reduce the profits to a point where the forest is hardly worth working.

It must not be overlooked that the large cash responsibility which a trader incurs when he makes a bid under the lump sum

system works against excessive bidding whereas under the outturn system the bidder feels that he incurs no responsibility unti he actually exports a piece of timber and he can then shuffle out of his responsibilities by exporting only a small quantity of good timber on which he is certain of making a profit.

The result of all these trials of different methods of sale may be said to be that at the present time we are suffering from an excess of traders who are led on by existing commitments or ignorance or other reasons to endeavour to keep their place in the trade by bidding amounts which are not justified and that it has been realised that under such conditions the lump sum system, as foreshadowed above, instead of increasing the troubles of the trade and the department tends to correct them.

The most recent decision then is to combine the lump sum system with a guarantee, the guarantee being, as explained above, for the protection of the department against undefined liability rather than with a view to improving revenue. It is felt that where the outturn does fall much below the expectations of the purchaser on account of many trees which have been classed as sound turning out to be hollow or partially hollow, it is impossible not to consider cases for compensation and that if compensation is to be given there must be something definite to base it on. In lots where no guarantee is offered the department will not give any estimate of the volume and will decline any responsibility.

It has further been realised that there is no *best* system but each should be considered according to its suitability at a given time and in a given area. When competition is slack and where volume of outturn is doubtful the Monopoly System will be advantageous, but it will always have the serious drawback of a tendency to restrict exploitation and the lesser one of involving a troublesome and harassing system of realising revenue at Chaukis. The system of payment on outturn only, will have its advantages where volume of outturn is very uncertain and reasonable competition is being hindered by that uncertainty.

F. F. R. CHANNER, I.F.S.

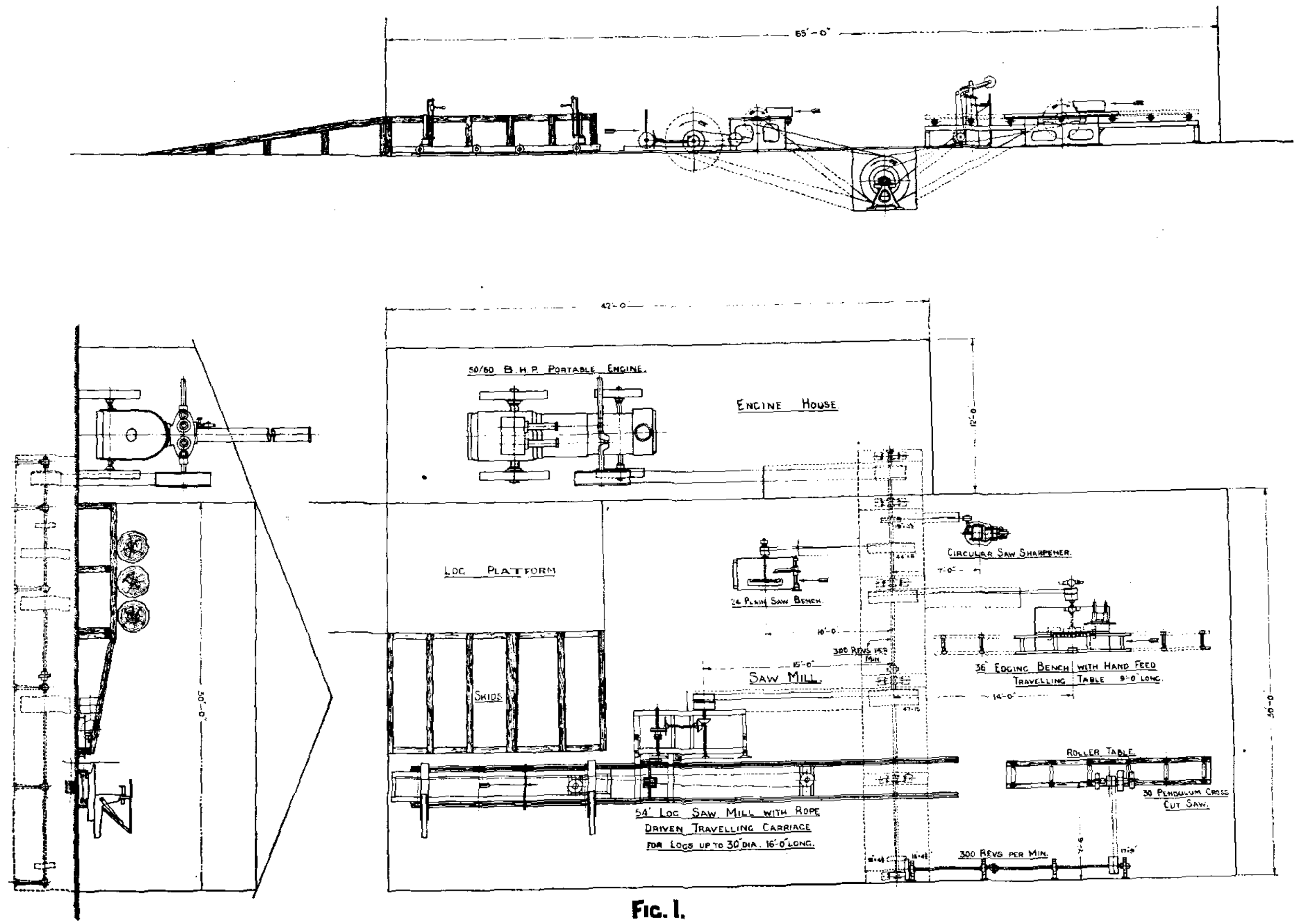

65'-0"
42'-0"
50'-0"
12'-0"
30'-0"
50/60 B.H.P. Portable Engine.
Engine House
Log Platform
Skids
24 Plain Saw Bench.
Circular Saw Sharpener.
Saw Mill.
300 Revs per Min.
36 Edging Bench with Hand Feed Travelling Table 9'-0" long.
Roller Table.
36 Pendulum Cross Cut Saw.
54' Log Saw Mill with Rope Driven Travelling Carriage for Logs up to 30" dia. 16'-0" long.
300 Revs per Min.
10'-0"
15'-0"
14'-0"
7'-0"

FIG. I.

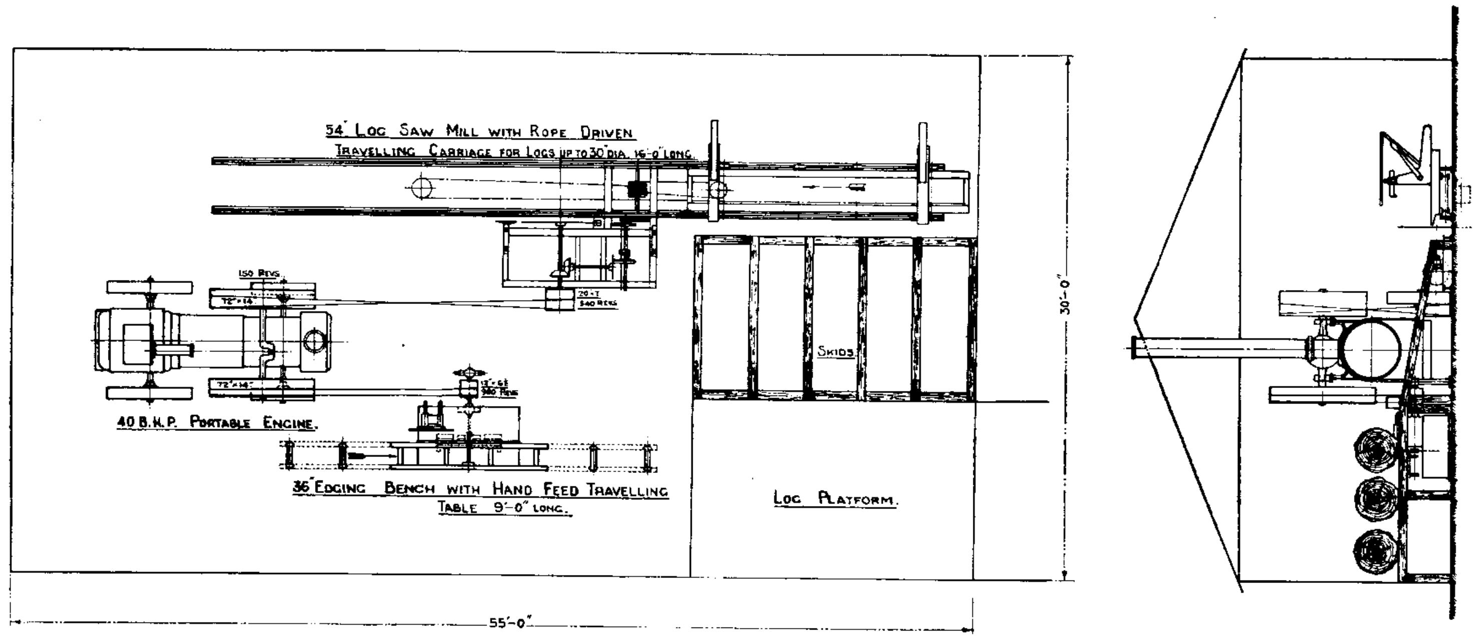

54" Log Saw Mill with Rope Driven
Travelling Carriage for Logs up to 30" dia. 16'-0" long.
150 Revs.
40 B.H.P. Portable Engine.
36" Edging Bench with Hand Feed Travelling
Table 9'-0" long.
Skids
Log Platform.
30'-0"
55'-0"

Fig. 2.

REVIEWS.

FOREST MENSURATION.

FOREST MENSURATION, by HERMAN HAUPT CHAPMAN, M.F., Hariman Professor of Forest Management, Yale University. Second Edition revised, XXII + 557 pages, 6 by 9, published by John Wiley and Sons, New York, 1924. Price 25*s.*

The first edition of this work was published in 1921 and reviewed at length in Volume XLIX, No. 2, of the *Indian Forester*. In the preface to the second edition the author states that the text of the second edition is identical with that of the first except that the reference lists of Volume and Yield Tables available in the United States of America have been brought up to date, and that the International $\frac{1}{4}$-inch kerf log rule proposed in the first edition has been relegated to a secondary place in favour of the International $\frac{1}{8}$-inch kerf log rule. This latter change is the

consequence of an increase in the intensity of timber utilisation. It is noted, however, that in the new edition the International ¼-inch rule is on page 84 still actually recommended as the best for a Universal Standard but possibly this is a statement left unaltered through oversight.

The review of the first edition may be referred to for details. The work has been written from the standpoint of American Forestry and it does not therefore embrace a complete study of European Forest Mensuration practice. Nevertheless it is easily the most comprehensive work on the subject published in the English language. The very fact that it has been written from the American standpoint rather enhances its value to the Indian Forest Officer as special attention has been paid to the problems of estimating volumes and predicting yields in irregular types of forest such as the majority of our Indian Forests comprise.

As an instance the author develops in detail the arguments in favour of making height and not volume the basis of quality in all forests whose stocking is abnormal and accidental such as is generally the case in India, in preference to the more usual European practice of making volume the basis of quality.

The book should be in the possession of every Working Plan Officer and of all other persons who have to deal with Forest Mensuration problems whether as buyers, sellers, or growers of timber.

It is obtainable from Messrs. Chapman and Hall, London, at a price of 25*s*.

DENSITY OF CELL SAP IN FOREST TREES.

KORSTIAN, C. F., Density of Cell Sap in Relation to Environmental Conditions in the Wasatch Mountains of Utah. *Jour. Agric. Res.*, Vol. 28, pp. 845—907, 1924.

In a 62-page article published in the Journal of Agricultural Research, Korstian presents the results of an exhaustive study of sap density of forest trees, herbs and shrubs in the Great Basin section of Utah. Concentration of cell sap determines

osmotic pressure which is the prime factor in the absorption of water by roots and its transmission through the plant. Osmosis is a process by which solutions of different density, when separated *by a porous membrane,* tend to mix and attain the same concentration by movement through the membrane in both directions. The stronger movement is, for a time, from the weaker to the stronger solution. Thus if a bladder partly filled with a strong solution of common salt, is placed in a vessel of pure water or a weak salt solution, the bladder will gradually fill and become greatly distended. If the walls are strong enough a pressure of many atmospheres may be developed. This is called osmotic pressure, which is really the pulling power of the substance in the solution upon the water outside of the bladder. After some time, the weaker movement from within the bladder to the outside reduces the pressure and finally a state of equilibrium is reached.

The cells of a root-hair act in much the same way as the bladder just described. An important difference is that a living cell is lined with protoplasm which has a strong affinity for water and resists the outward movement of water from the cell. In order to draw moisture from the soil, the root-hair must contain a solution of higher concentration than the soil water. When the ground is wet, the soil solution is usually weak, but when the ground is dry the solution may become so highly concentrated that the root *cells cannot absorb it. This is especially the case* if the soil contains large quantities of soluble salts. Usually, however, the root cells are taking in water from the outside. This tends to weaken their solution, and these cells in turn lose water to adjoining cells of higher concentration. Thus, water moves from cell to cell until it reaches a system of long tubular cells or vessels through which it is forced up the stem, largely by osmotic pressure. Starting from the other end of the system, the action is something like this. Leaf cells, by losing water or by manufacturing carbohydrates, increase the density of their sap. Immediately they draw upon neighbouring cells containing a weaker solution, thus automatically increasing the concentration of the latter. These in turn draw on the cells beyond, and thus the osmotic equilibrium is upset all along the line.

Korstian has determined the sap density, which is an index of osmotic pressure, in several hundred plants including trees, shrubs and herbs in various vegetational zones at altitudes of from 4,000 to 10,000 feet above sea-level. The determinations were made by the freezing-point depression method as developed by Harris, Gortner and Lawrence. Korstian has consulted personally with these specialists in regard to equipment and technique. In brief, the juice or sap is pressed from the leaves or stems to be tested and placed in a glass tube which is imbedded in a mixture of ice and salt. The temperature at which sap freezes is determined by its density, being several degrees below the freezing point of water in saps containing a large proportion of soluble matter. The temperature at which freezing takes place is measured by means of Beckman's thermometer which registers to a thousandth of a degree, Centigrade. From the depression below the freezing point of pure water the osmotic pressure may be calculated by means of formulæ.

The following are some of the outstanding conclusions announced by Korstian :—

Sap densities are higher in the leaves than in the roots of the same plant, and they are higher at the top than at the base of the crown of a tall tree.

Density increases through the day but decreases toward night. The minimum occurs in the morning. This indicates a relationship between sap density and photosynthesis. Transpiration doubtless is also a factor. Shade plants have a lower concentration than sun plants of the same species. Young growing leaves and shoots have a lower sap density than older tissues. This explains why young shoots are most sensitive to frost.

Ligneous plants have a higher concentration than herbaceous plants.

On a given site, the concentration of cell solutions varies from season to season. It is low in the spring, evidently because of abundant soil moisture and low temperature, with low rates of transpiration and photosynthesis. It is high in midsummer because the soil is relatively dry and transpiration and photosynthesis

are proceeding at a rapid rate. It decreases in the fall with decreasing temperature and increasing rainfall.

In winter the conifers, with the exception of juniper, have a low concentration while evergreen broad-leaved shrubs have a high concentration. This divergence is explained by the discovery that the conifers in winter transform the starch into oils of relatively low osmotic activity, whereas the evergreen shrubs convert the starch into soluble sugar which greatly increases the osmotic action.

The average sap density of a large number of plants including trees, shrubs and herbs in each association from the greasewood-shadscale up through the woodland, aspen-fir and spruce-fir association showed a gradual decrease with altitude. The same relation was shown by trees alone from the lowest to the highest forest types, except that as timber line was approached the sap density increased. An increase is generally shown on dry or exposed sites as compared with more favourable situations. The same species has a higher sap density at the lower than at the upper extremities of its range. Average osmotic pressures for various associations are as follows :—

Greasewood-shadscale 51·4 atmospheres, sagebrush 28·2, pinon-juniper 21·4, oak brush 17·7, aspen-fir 15, spruce-fir 14.

It is concluded from these findings that species which are able to develop high osmotic pressure or sap density, at the same time maintaining a normal transpiration current, are better fitted to grow on a dry site than are species which are not capable of developing high osmotic pressure. Plants growing on dry sites where the soil solution is highly concentrated must have a dense sap in order to draw sufficient moisture from the soil. Plants growing on moist sites, however, do not need a dense sap because water is more abundant and the soil solution is relatively dilute. In afforestation the possibilities of various species on dry sites may be tested by comparing their normal range of osmotic pressure with that exhibited by plants on the ground.

Korstian's work, from the standpoint of amount and variety of material used, methods employed and correlation of results from different angles, gives an impression of conclusiveness which

does not always appear in research papers. Besides presenting a creditable array of his own data, he has apparently made an exhaustive study of related literature.

G. A. PEARSON.

THE WATER-HYACINTH AND ITS UTILIZATION.

(BY ALBERT HOWARD, C.I.E., M.A.)

In a recent review * of the work done by the Agricultural Department in India during the last twenty years, attention was directed to the profitable utilization of the water-hyacinth in increasing crop-production in Bengal. The suggestion was thrown out that this water weed should no longer be regarded as a pest to be destroyed but should be converted into valuable manure for jute and rice by means of the Chinese methods of composting crop residues described by King in "Farmers of Forty Centuries." The matter was referred to in *Capital* of January 22nd last (p. 131) and again on February 5th by Dr. Gilbert Fowler in his article on the water-hyacinth problem (p. 242).

In connection with a series of experiments at the Institute of Plant Industry, Indore, on the conversion of crop residues into finely divided organic matter suitable for the cotton crop, results have just been obtained which leave no doubt that the profitable utilization of the water-hyacinth in Bengal and in Burma is a practical proposition. In the Indore experiments, one of the materials employed was water weed obtained from the local river. This was mixed in the fresh condition with earth, cow-dung and wood ashes in the Chinese fashion in a compost heap. To begin the heap five cartloads of the weed were spread on the ground in the form of a rectangle—eighteen feet by twelve —and about nine inches deep. Half a cart-load of earth, half a cart-load of ordinary farmyard-manure and two baskets of wood ashes were then spread uniformly on the weed, moistened with water and the whole mixed. A second layer of water weed was added and again mixed with moistened earth, cow-dung and

* "Crop-production in India," Oxford University Press, 1924.

wood ashes as before. This procedure was continued till the heap contained from thirty to forty cart-loads of the weed. The heap was then lightly covered with earth to prevent excessive drying and left for a month. An active fermentation at once began and the water weed was rapidly broken down into a damp moist mass. At the end of the first month the heap was turned to promote thorough æration. By the end of the second month the fermentation was completed and the water weed was converted into finely divided organic matter resembling moist leaf mould. This material, when added to the soil stimulates growth in a remarkable manner and is proving a valuable manure.

There is every reason to believe that the above treatment would produce similar results if applied to the water-hyacinth in Bengal and Burma. The only modification likely to be necessary is to adjust the moisture in the water-hyacinth before composting so as to prevent water oozing from the head. If this takes place a loss of valuable material would result. This loss could easily be prevented by allowing the weed to wither for a few hours in the sun before being used for the compost. The best time of year to convert water-hyacinth into Chinese compost would be after the monsoon between October and March when the work could be carried out in the open air. During this period a large volume of compost could be prepared for the cold weather crops, for the jute areas, for rice nurseries and for vegetable and fruit gardens.

It will naturally take some years before the ryots of Bengal realise the great value of the water-hyacinth in increasing crop production. A beginning, however, can be made at once by many private individuals interested in gardening and fruit-growing. The experience thus obtained will soon begin to filter down to the people. If at the same time organisations like the Universities, the Agricultural and Co-operative Departments and Agricultural Associations take up the work, progress will be rapid. At all Agricultural Exhibitions in Bengal substantial prizes should be offered for the best compost made from the water-hyacinth and for produce raised with this manure.

[*Capital, LXXIV, No* 1862.]

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SOME NOTES ON LAC CULTIVATION.

During the last two or three years I have had to investigate the position of the lac industry in Bihar and Orissa with a view to determining the possibility of extending the cultivation of lac both inside and outside of Government forest areas. During the course of this investigation I have become more and more struck with the vastness of the extent of our ignorance of the whole subject of lac cultivation. There are only one or two works which deal with the subject and the information they give is generally somewhat sketchy and often inaccurate. As the subject is one in which the Forest Departments of several provinces are now taking an interest, I give below some notes on it which are based partly on actual experience but mostly on information, which I have not at all been able to verify, collected personally from various centres of cultivation. While these notes may contain nothing which is new to those who have had a considerable practicable experience of lac cultivation they may prove of some interest to others who have recently taken up the subject and who have only existing works to guide them.

DISTRIBUTION OF LAC INDUSTRY.

The commercial possibilities of growing lac in any particular locality depend on the following principal factors which are more or less inter-related :—

(*a*) Climate, (*b*) Environment, (*c*) Soil-conditions, (*d*) Presence of suitable hosts, (*e*) Absence of insect enemies.

(*a*) CLIMATE.—The evidence of recent writers may be dealt with first. Lindsay and Harlow* state with regard to climatic conditions "We know that strong and dusty winds, frost, hail and heavy rain are all likely to cause serious loss at the critical periods of larval and male emergence; but as regards what may be called climatic distribution we have no definite or precise knowledge. That is to say, given an acquaintance with the meteorological data relating to the temperature, rainfall, and humidity of any particular place, we cannot say definitely whether that place is climatically suited to the lac insect or not."......... "All that we know at present is that areas where lac is at present most abundantly grown, namely, Chota Nagpur, Orissa, and the east of the Central Provinces, are generally over 1,000 feet above sea-level and enjoy a fairly temperate climate. The annual rainfall is from 50 to 60 inches and occasional showers are secured during the winter and summer months outside the regular rainy season. The general humidity is low. Frost, although fairly common in parts of the tract such as Damoh, can be avoided on the hill slopes, and hail, heavy tropical rains and dry hot winds are uncommon." Again in their remarks on lac cultivation in different districts the authors write as follows: "This district (Santal Parganas) together with the adjoining areas in the Murshidabad and Malda districts of Bengal, presents somewhat of an anomaly as a lac growing area, on account of its low altitude, most of it being below 600 feet. The reason why lac is found at this level is not definitely known. All that can be said is that the favouring rains of the cold weather are usually well distributed in the Santal Parganas, while the dry west winds of the open season, which are always adverse to lac cultivation, are not prevalent." Writing of the Punjab they say "The province as a whole has climatic conditions too extreme for the successful propagation of lac. The exception, Hoshiarpur district, is a distinct anomaly and produces qualities of lac of some importance to the trade." They go on to explain that the apparent cause of this anomalous growth of lac is that the lac bearing area lies in a

* "Report on Lac and Shellac," by H. C. F. Lindsay and C. M. Harlow, Indian Forest Records, Volume VIII, Part I, 1921.

narrow valley shut in between the Himalayas and the Siwaliks in which one would expect to find special climatic conditions ruling, such as a greater rainfall and more favourable climate. Writing of Sind they state "Sind is usually considered one of the hottest and driest parts of India. This being so the occurrence of lac there must be regarded as somewhat of an anomaly. A suggested explanation is that on the lower Indus sea breezes during the hot weather do much to reduce the severity of the climate." Of Assam they say "The distribution is mainly in the hill tracts and it seems as if the plains are too humid for lac cultivation," and of Burma they state that in the north lac cultivation is found at lower elevations than further south such as Henzada district where lac grows only on the tops of the hills above 2,200 feet.

Misra* writes "Places which are neither very hot nor very cold and where the annual rainfall is about 30 inches are suitable for lac cultivation. Moisture is a great necessity for the successful development of the insect but if it is in excess it affects the crop injuriously. Dry, arid places are to be avoided in starting the cultivation. Extremes of heat and cold retard the growth of the insect. With heat the resin melts; the air holes, through which the insect breathes, are blocked, and it dies of suffocation." Writing of hot winds in particular he states "The crop, if exposed, is seriously damaged. The body contents of the female insects dry up and in consequence the female dies. This is apparent by the pitting up of the resinous cells in the centre. The colour, too, of the cells affected with hot winds, changes. They become translucent, pale brown, with the shrivelled up body in the centre. In some cases, when the hot winds continue to blow for a number of days at a stretch, the resin melts and drops down on the ground, leaving the dead females sticking up on the branches of the trees."

Hautefeuille† states that Misra's remarks are confirmed by experience in Indo-China but he is convinced that the limits for

* "The cultivation of lac in the plains of India," by C. S. Misra, Agricultural Research Institute, Pusa, Bulletin No. 142, 1923.

† "Translation of M Hautefeuille's Report on Lac and its Industrial Treatment," by S. M Hassan, Department of Industries and Commerce, His Excellency's Highness the Nizam's Government, Bulletin No 2, 1924

the successful cultivation of lac are even more restricted. He adds "We know now that *Coccus lacca* does not thrive either below 1,300 feet or above 2,200 feet, that it needs an airy locality but is injured by violent winds, beating rains, excessive heat and prolonged drought."

Summarising the above views it may be said that the above writers lay most stress on the necessity for a certain elevation, temperate climate, a moderate humidity and rainfall, and an absence of hot winds. With these conclusions I am not in general agreement and I therefore give below the details of the climatic conditions which appear to me on the present evidence available to explain most satisfactorily the existing distribution of the industry.

(1) *Elevation.*—All the evidence in my opinion goes to show that elevation *per se* is a physico-geographical factor of no importance. The four main lac growing districts in India are Manbhum, Palamau, Ranchi and Singhbhum. In Manbhum district practically all the lac is grown below an altitude of 1,200 feet and in Singhbum and Palamau below an altitude of 800 feet. In Ranchi district the principal lac growing thanas are situated on the lowest plateau of about 1,200 feet elevation and not on the main plateau of an elevation of 2,000 feet. The lac growing areas in Sind, the Santal Parganas, Murshidabad, Malda, etc., are not therefore in the least anomalous as regards their elevation. The probability is that lac would grow successfully at sea-level but ordinarily other conditions such as humidity would be unfavourable in close proximity to the sea. There is also no evidence to show that high elevation is in itself an unfavourable factor. Lac is grown successfully in parts of Ranchi, Sirguja and Jashpur at elevations of about 3,000 feet. The uppermost limit of cultivation is probably determined by humidity and temperate and will prove lower in a cold wet than a hot dry region.

(2) *Temperature.*—There is no doubt that frost is injurious to and cold, especially damp cold, inhibitory to the growth of the lac insect. As in the plains of India cold is not continuous day and night it is probable that frost rather than prolonged cold

is the determining factor which limits cultivation. The above authors all agree in stating that extreme heat is injurious to the lac insect, but their ideas of extreme heat are not such as will receive popular support. Manbhum, Singhbhum and Palamau districts are amongst the hottest in India with a shade temperature which may reach a maximum of 118 degrees. This will hardly be considered temperate except by denizens of the nether regions. If we add to this evidence the fact that lac is grown successfully in Sind and Hoshiarpur it would not appear that extreme heat can be injurious. Misra states that with heat the resin melts with the result that the insects' air holes are blocked. I have seen instances of this but I consider that the cause is not heat in itself but the fact that the physiological activity of the host has been adversely affected by drought. Provided that the edaphic conditions are favourable to the growth of the host I do not think that heat is ordinarily an injurious factor though in exceptional cases such as when there is excessive radiation of heat from the soil this may prove the case. Mahdihassan * in commenting on the failure of the summer crop of lac in Hyderabad State in 1922 states that in his opinion the failure was due to drought rather than heat. This observation tends to confirm the above remarks.

(3) *Rainfall.*—Lindsay and Harlow's statement that the usual rainfall in lac growing areas is 50″ to 60″ per annum is much nearer the mark than Misra's statement that the annual rainfall of about 30″ is required. The main lac growing areas in Bengal and Chota Nagpur have an annual rainfall of 50″ to 57″ with the exception of Palamau district where it is 45″. The actual quantity of rainfall is of less importance than its distribution. Rain in November, December and January is unfavourable as it induces mist and cold damp conditions which are certainly unfavourable to the growth of the insect. In all the main lac growing areas of Bengal and Chota Nagpur the average monthly rainfall in these months is under 1″. Again some rain in the hot weather months of April and May is beneficial as it washes off

* Journal of the Indian Institute of Science, Volume 7, Part VII, 1924, "Contribution to the Scientific Study of the Lac Industry, Part VII. Significance of Sex Differentiation among Lac Insects," by S. Mahdihassan.

the "honey dew" and except in districts such as Murshidabad, Malda, etc., where the rate of transpiration is reduced by a higher humidity or except in localities where there is always sufficient moisture in the soil to permit of the host growing normally some rain in these months is necessary to provide the host with water. Further it is obvious that localities subject to heavy rain at the times of the larval and male emergence would not be favourable localities for the insect. As larval emergence occupies a period of several weeks the rainfall of a locality must be exceptionally heavy if it is usual for such prolonged continuous rain to occur. The maximum rainfall which will allow of lac cultivation is best determined by a study of conditions in places such as Assam, Burma and Indo-China. It is likely to depend on factors such as humidity, *e.g.*, Ranchi has the heaviest rainfall in Chota Nagpur but the lowest average humidity. As a high humidity is adverse to lac cultivation (see below) a heavier rainfall would be permissible in tracts where the average humidity is not too high. As regards the lower limit of rainfall, provided the soil is kept sufficiently moist through infiltration or irrigation to permit of the host tree growing normally there seems to be no reason why lac should not be cultivated in localities with a rainfall of only a few inches. Some rain is probably necessary to wash off honey dew and keep the crown surface clean but in its absence artificial spraying should serve the purpose.

(4) *Humidity.*—There seems to be no doubt in my opinion that the humidity of the air is an all-important factor in determining the limits of lac cultivation. The main lac growing areas all enjoy a low average humidity and the lower the humidity the better the quality of the lac. All the districts enjoy a uniformly high humid climate during the rainy season, but during the rest of the year the districts vary in this respect. The average relative humidity during the period from October to May is 80 in Murshidabad, 65 in Manbhum, 70 in Palamau, and 58 in Ranchi district. Considering the relative values of the *baisakhi* crops, the pure *ber* (*Zizyphus Jujuba*) crop of Murshidabad district is slightly inferior in quality to the *ber* crop from *palas* brood grown in parts of Ranchi and

Manbhum districts and markedly inferior to the pure *ber* crop of the latter two districts. It is only slightly superior to the pure *palas* crop of Palamau district. Again in all these districts the *baisakhi* crop is of better quality than the *katki* crop which is the one grown under the more humid conditions of the rainy season. The difference in quality is due to the darker colour of the lac grown under more humid conditions which restricts its use to the manufacturer of ordinary T. N. Shellac. Where humidity is not too high, such as in Murshidabad and Malda districts, the decrease in quality is more than counter-balanced by bigger incrustrations which yield a slightly higher relative outturn than lac grown in drier regions. As one proceeds further east into Assam, Burma and Indo China the quality of the lac becomes still more inferior such that its inferiority is probably no longer offset by increased yield. In fact in Indo-China the lac suffers from a further defect in that it sometimes proves to be insoluble alcohol. Whether this defect is a result of humidity or not is not known. The difference in quality in the *baisakhi* crops according to the relative humidity is similarly exhibited by *kusmi* and *jethwi* crops which generally deteriorate in quality as one proceeds from Raipur eastwards through Ranchi to Manbhum districts. The only exception to the statement that the value of the lac crop depends on the humidity of the air would appear to be afforded by Sind, the lac crop of which is of poorer value than that of the main lac growing area. This may be due to the species of host used or it may be due to sea breezes increasing the humidity of the air. I would add that I have been informed by lac cultivators in this province that a south wind, which is a humid wind coming from the Bay of Bengal, is bad for the lac crop. This opinion serves to confirm the statement that a high humidity is adverse to the lac crop. A further confirmatory feature is that the lac crop requires a free circulation of air in order to grow well and the main value of such air circulation probably lies in reducing the humidity of the air.

To sum up the main lac growing area has a low humidity. On its eastward fringe in the districts of Murshidabad, Bankura,

Midnapur, etc., the humidity rises and the quality of the crop becomes lower. Conditions in Orissa have not been studied but it is notable that the extent of lac cultivation decreases as one proceeds southwards towards the Bay of Bengal. The poor quality of the Assam, Burma and Indo-China crop would appear to be due also to a high relative humidity but this requires further local investigation. The bigger comparative yield of lac in districts on the eastern fringe of the main area is probably not due to the humidity *per se* but to the fact that the host trees grow more vigorously owing to there being more moisture in the soil and a reduced transpiration. The hosts moreover are generally manured. In Manbhum district the incrustration on irrigated *ber* trees are superior to those on unirrigated trees. I do not know however how far the quality of these incrustrations compares with those on unirrigated trees or with those on trees in Murshidabad district.

(5) *Wind.*—All the districts of Chota Nagpur including the Santal Parganas are swept by hot west winds during the months of April and May and it is obvious that if these were such an adverse factor as the above quoted authors make out the lac industry would not be in its present flourishing condition. Hot winds appear to be harmful only when the soil is insufficiently moist to support the increased transpiration of the host which is induced by such winds, or in very dusty localities such as road-sides (and possibly the treeless plains of Pakur in the Santal Parganas) where they smother the host trees with dust. Violent winds are probably only harmful to lac crops growing on fragile trees or on a field crop such as *arhar* (*Cajanus indicus*). Cold winds inhibit the growth of the insect, while high winds at the time of swarming are bad.

(6) *Hail.*—Is certainly injurious and localities subject to frequent hail storms are not suitable for lac cultivation.

This concludes the evidence regarding the climatic qualifications necessary to the successful cultivation of lac.

(*b*) ENVIRONMENT.—There are certain conditions of environment which affect the lac crop and which may be briefly referred to.

(1) *Light.*—Is essential but partial shading from the south and west stops excessive transpiration and on dry soils such shading may prove beneficial by helping to maintain the physiological activity of the host.

(2) *Protection from wind.*—As mentioned above free circulation of air is necessary for the crop and to get good results hosts in a forest area should be freed from contact with other trees. At the same time in dry localities the lac crop is assisted by the presence of neighbouring trees, or shelter belts which check excessive transpiration of the host.

(3) *Air pollution.*—The fumes from lac dye are said to be injurious to the lac insect and the lac crop will not do well when cultivated in the vicinity of a shellac factory.* In Manbhum district the lac cultivation is now almost confined to the Sadar Sub-division. It is stated that lac cultivation was once more extensive in the other sub-division, Dhanbad, but that with the growth of the coal mining industry the air has become too impure to permit of successful cultivation. This would indicate that lac will not do well in the neighbourhood of manufacturing centres.

(4) *Fires.*—Forest fires are naturally injurious to the insect owing to the excessive heat induced and their withering effect on the crowns of the hosts. In the case of large sized hosts such as *kusum* the injury caused by forest fires is probably slight.

(*c*) SOIL CONDITIONS AND (*d*) PRESENCE OF SUITABLE HOSTS.—These two factors are too inter-related to be considered separately. The chemical composition of the soil suitable for lac cultivation need not be dealt with here as the subject has not yet been properly investigated. It is sufficient to state that pot culture experiments†, recently carried out at the Indian Institute of Science, Bangalore, indicate that lime, nitrogen and phosphorus are essential and potash unessential for the growth of

* It is possible that this phenomenon is due to the attraction of the parasite *Eublemma amabilis* to lac dye.

† Preliminary results were published in the Journal of the Indian Institute of Science, Volume 7, Part VII (1924). Contributions to the Scientific study of the Lac Industry, Part III. The investigations are still in progress.

the insect. The soil condition of most importance is that the soil must always contain sufficient moisture to permit of the host plant being vegetatively active at the time when the lac insect is itself in a state of physiological activity. The amount of moisture required depends on the species of host. The period when the moisture contents of the soil tend to fall too low is in India the hot weather. The actual amount of moisture in the soil during this period will depend on the physical texture of the soil, the water-level, and the capacity of the soil for allowing summer showers to percolate through the upper layers. Clay soils and soils with a pan near the surface do not allow water to percolate through to the absorbing root system and in dry localities where the moisture contents of the soil fall too low unless supplemented by summer showers such soils are unsuitable to the production of brood lac.

Lindsay and Harlow state that in India most trees "have two periods in the growing season when their vegetative activity is much greater than usual" ... .. "These periods are in the hot weather preceding the rainy season, and again in the autumn immediately after the rains. Most trees produce long shoots at both these periods and the flowering time is frequently at one or other of them. With a view to further consideration and enquiry it is here suggested that the period of intense lac production immediately following the impregnation of the female lac insect coincides with or is in some way dependent on the corresponding period of vegetative activity of the host ; and that is the reason why the winter brood takes so long to mature, and why a comparative small amount of lac is produced before March, is that the host is then inactive and its branches contain very little sap before that month."

Their theory that there is an intimate relation between the period of intense activity on the part of the insect and the period of vegetative activity on the part of the host is probably without doubt true. It must be pointed out, however, that certain hosts such as *ber*, *ghont* (*Zizyphus xylopyra*) and *khair* are xerophytes which are generally leafless during part of the hot weather during which period they are inactive. They do not produce long

shoots at this period unless they are pruned or coppiced. The reason why they and other similarly deciduous trees are vegetatively active only after pruning or coppicing is probably due to the fact that the root system cannot supply sufficient moisture to keep a full crown surface going, but it is able to supply sufficient moisture for a series of new growing shoots with a small transpiring surface. As will be shown below it is precisely these xerophytic hosts which present the greatest problem with regard to the cultivation of a hot weather crop of lac.

The characteristics of two or three of the most important species of hosts and their relationships to the soil condition and lac production will now be dealt with. To begin with it may be said that there appears to be in this province no difficulty in growing a *katki* crop on any host as the soil conditions during the period of the growth of this crop are favourable. Exception may occur in the case of trees growing on water-logged soil, but I have not heard of any. The following remarks apply therefore only to the summer crop:—

(1) *Kusum.*—The leaf shedding habit of this tree appears to be fairly constant throughout the province in all localities. The tree is leafless for a maximum period of one month in February-March and in common with other forest trees, such as *sal* it is vegetatively active throughout the hot weather. As a result it is possible to grow the *jethwi* crop on it wherever it is found. I have never heard of instances of this crop failing through lack of moisture but it is possible that in exceptional years or on dry soils the moisture contents of the soil become insufficient to maintain the growth of the tree vigorously enough for the development of the lac crop. The probability is that climatic and other factors being favourable this species will support a *jethwi* crop wherever it is found naturally.

(2) *Ber.*—The period of vegetative activity of this species varies greatly according to the humidity of the air and moisture contents of the soil. In Western Bengal the tree is an evergreen, the new leaves appearing as the old leaves are shed. In very dry localities the old leaves are shed early in April and the new leaves do not appear until the break of the rains. In interme-

diate localities the tree remains in leaf until about the end of May, the new leaves appearing on the break of the rains. New leaves in dry localities may come out in April or May if a moderate amount of rain falls. This variable activity on the part of this species greatly affects the prospects of growing a *baisakhi* lac crop successfully. This point was first brought to my attention by Mr. Harlow who, experimenting in South Raipur division, failed to get any results on *ber*. I have since pursued enquiries on the subject with the following results. In the Western Bengal districts where the tree is evergreen there is no difficulty in growing a successful crop. This is probably also true of almost the whole of the central Ranchi plateau where owing to the more temperate climate the trees remain in leaf until about the end of May, but the trees are more lightly infected than in West Bengal.* In the Santal Parganas in a normal year hardly one per cent. of the *ber* trees appear to be able to support a light mature crop. In Manbhum and Singhbhum districts only about 10 per cent. of the *ber* trees, and in Palamau district a still smaller percentage appear to be capable of producing a light mature crop. In all these districts the insect develops sufficiently to yield a commercial crop in April or May but it would appear that in still drier localities such as Raipur not even an immature crop can be obtained. Within the above mentioned districts the leaf-shedding habit varies remarkably according to the soil. It is a common sight to see one tree in full leaf and beside it a few yards away one entirely leafless. The cultivator knows which of his trees are capable of yielding brood lac. Winter *kusum* brood is not suitable for infecting *ber* as it swarms too late and the insect does not mature sufficiently before the host becomes leafless.

I have heard statements to the effect that in parts of Singhbhum and Manbhum districts the lac crop on *ber* swarms in May and if this is the case—I have not been able to verify the fact—it means that in such localities the majority of *ber* trees will be capable of producing summer brood. A reported adaptation of

* The hot weather of 1925 was exceptionally favourable as a good deal of rain fell in May. The result was that a great deal of brood lac was grown on *ber* in the Santal Parganas.

this early swarming to a particular system of cultivation is referred to below.

(3) *Palas.*—The *palas* tree is fairly regular in its leaf-shedding habit. In moister localities the new leaves come out as the old ones fall but, as a rule, the tree is completely leafless for about a month in March--April, and partially leafless for a longer period when in flower. Owing to its brief period of vegetative inactivity the lac crop on *palas* survives to maturity in almost all parts of the province. Exceptions to this rule occur in Palamau district. On the black cotton soil of the Government brood lac farm at Kundri the crop does not in an ordinary year reach maturity except when the host is growing along depressions where the soil is moister or except when the trees are lightly infected. Winter *kusum* brood does not do well on *palas* but better than it does on *ber*.

(4) *Khair.*—The species is leafless for two or three months and in dry localities it is not even possible to obtain an immature commercial crop in April. In moister localities a commercial crop is obtainable but with experience so far gained it is doubtful whether except on particularly moist areas it will be possible to grow brood lac. Winter *kusum* brood will not do at all on this species.

(5) *Ghont.*—This species is never utilised as a host in this province. One or two attempts have recently been made by the department to grow lac on it but with unsuccessful results. It is referred to here because in view of what has been written above this species would appear to be rather anomalous in that being leafless for three or four months it can still produce brood lac in the Central Provinces. Mr. McDonald, late Divisional Forest Officer, Damoh, has informed me that in one and the same locality there are some trees in leaf and others not and that the trees without leaf in June have a very high percentage of mortality as compared with those in leaf. The more heavily infected the tree is the later it is in coming to leaf and heavily infected trees are liable to die. It is probable, therefore, that soil conditions govern the production of brood lac on this species also. This species has not been sufficiently experimented with in this pro-

vince to judge whether it will prove a host of commercial possibilities but it may be noted that the *ghont* lac bearing areas in the Central Provinces are mostly situated on plateaux above 1,000 feet. These areas are likely to enjoy a brieter and less severe hot weather than most *ghont* areas in this province and under the same conditions of soil and environment a lac crop may be produced in the one province and not in the other.

(6) *Arhar.*—This plant is not a lac host in this province but it affords a good example of the influence of soil conditions. In Assam the plant lives for three or four years. In this province it only lives for about 10 months. It is too small to infect in July and a hot weather brood lac crop is impossible owing to the death of the host. I have seen fields of *arhar* in April which have been naturally infected with lac but the crop appeared unhealthy and it is probable that it is not commercially practicable to grow any hot weather crop on it. Experiments are now being tried in sowing *arhar* as early as possible and in heavily manuring the plants with the object of getting them big enough to infect in July or August with a late swarming variety of brood such as *kusum*. These experiments may prove very successful.

The foregoing remarks will help to illustrate the importance of moisture as a factor which influences the production of brood lac on certain important host trees, and the fact that a suitable host in one locality may not prove a suitable host in another locality. They may explain the general failure of *babul* as a host in Bihar which Misra and Lindsay and Harlow comment on, as in Sind it is probable that the lac bearing trees are all situated on soils kept moist by infiltration from canals.

It may be added that apart from the quantity of the sap of the host the quality of the sap appears to be an influential factor. In the rains of 1924, 900 old *ghont* trees were infected for the first time in Sambalpur Division. The lac developed satisfactorily until September when it all died. The failure can hardly have been due to pests such as ants, and as climatic conditions were entirely favourable, the only apparent cause of the failure is that there was something wrong with the sap of the host, though it is not impossible that the *ghont* trees in this province are a different

variety from those infected in the Central Provinces. The sap theory is more probable as the above is not the only instance of an unaccountable failure. I have heard of an instance in which the lac crop on some old *ber* trees inoculated for the first time completely failed the first season, succeeded partially in the second season and completely in the third and succeeding seasons. I have also been informed by lac cultivators that *Dalbergia latifolia* may have to be infected for as many as seven or eight seasons in succession before the crop succeeds. Once a crop takes it always takes. It would, therefore, appear that by means of repeated infections the quality of the sap changes to a degree which affects the growth of the insect.*

(*e*) *Absence of insect enemies.*—The lac insect has a large number of insect enemies but athough these may damage the crop severely they rarely inhabit lac cultivation entirely. An exception must be recorded in the case of certain small ants. Misra records that in some places, especially those in which the cultivation of lac has been started for the first time, the inoculated trees are frequented by ants in large numbers which lick the honey dew and cause the death of the females. Hautefeuille states that in certain parts of Indo-China lac cannot be cultivated owing to the trees being infested with small black ants. In other parts these ants occur but they are preyed upon by a larger species of ant and their numbers are kept sufficiently down to permit of the cultivation of lac. Misra also states that in some localities the moth *Eublemma amabilis* is so plentiful that all attemps made in the past to introduce lac cultivation there have failed. The possibility therefore of such enemies occurring must be borne in mind in starting cultivation in a new locality.

Other obvious factors which influence the distribution of the lac industry such as those of labour-supply, liability to theft, etc., need not be dealt with here

This concludes the survey of the factors that influence the distribution of the lac industry. If the above opinions are correct

* The change may be due to a reduction in the percentage of potash which is generally concentrated in growth apices. If so it is likely that repeated pruning rather that repeated infection causes an alteration in the chemical nature of the sap.

it should be possible to prove that no areas in which lac cultivation is now carried out are anomalous, and by a careful study of the factors of any given locality it should be possible to forecast the potentialities of cultivating lac on it.

(To be continued.)

J. W. NICHOLSON, I.F.S.,
Provincial Research Officer,
Bihar and Orissa.

THE ALLAPILLI SAW MILL.

A brief history of the operations in the Allapilli Forests of the South Chanda Division, Central Provinces, may first be roughly outlined, prior to giving some description of the saw mill :

The Allapilli reserve was under departmental working before 1912 when a number of compartments were leased out to a firm for a period of 10 years. The firm began work the same year and erected a saw mill at Allapilli in conjunction with their working. This lease, however, was terminated in 1918, as it proved unsatisfactory, and the firm dismantled their mill. Departmental exploitation was thereupon re-commenced and a project for the establishment of another saw mill at Allapilli, to be worked departmentally, was put forward. In 1921, Mr. Lafon, Consulting Engineer to the Government of India, visited Allapilli and reported in full detail on the operations there, making also many recommendations. In view of this report, and of other considerations, Government decided to erect a mill at Allapilli to be worked departmentally.

Machinery for the mill, except boiler and plant, was ordered from Messrs. Clarke Brothers, Olean, New York. The machinery was set up and plant installed by Messrs. Turner Hoare and Co., of Bombay. The mill was started under departmental working on the 16th November 1924.

The mill is situated at Allapilli, 62 miles from Ballarshah Railway Station (G. I. P. Railway) and a first class P. W. D. road connecting this station with Allapilli, is at present used as the main line of export. That portion of the Allapilli Forest now

variety from those infected in the Central Provinces. The sap theory is more probable as the above is not the only instance of an unaccountable failure. I have heard of an instance in which the lac crop on some old *ber* trees inoculated for the first time completely failed the first season, succeeded partially in the second season and completely in the third and succeeding seasons. I have also been informed by lac cultivators that *Dalbergia latifolia* may have to be infected for as many as seven or eight seasons in succession before the crop succeeds. Once a crop takes it always takes. It would, therefore, appear that by means of repeated infections the quality of the sap changes to a degree which affects the growth of the insect.*

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Other obvious factors which influence the distribution of the lac industry such as those of labour-supply, liability to theft, etc., need not be dealt with here

This concludes the survey of the factors that influence the distribution of the lac industry. If the above opinions are correct

* The change may be due to a reduction in the percentage of potash which is generally concentrated in growth apices. If so it is likely that repeated pruning rather that repeated infection causes an alteration in the chemical nature of the sap.

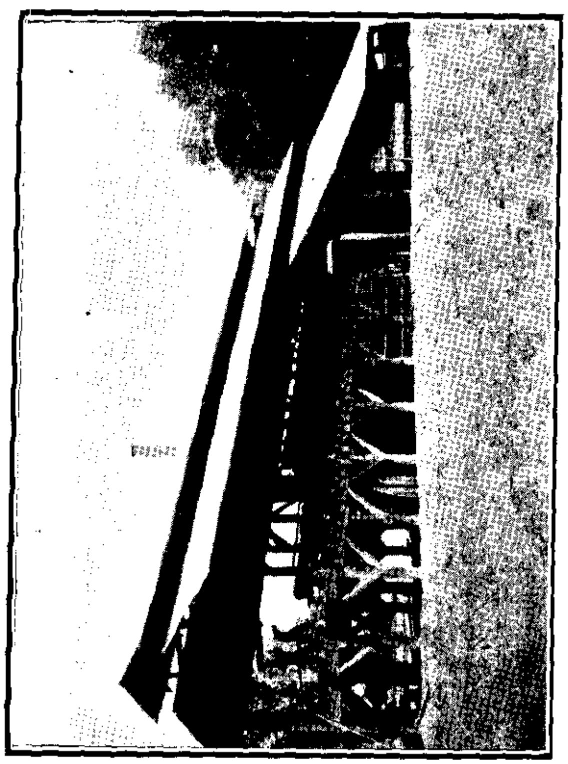


Fig. 1. The Allapilli Saw Mill.

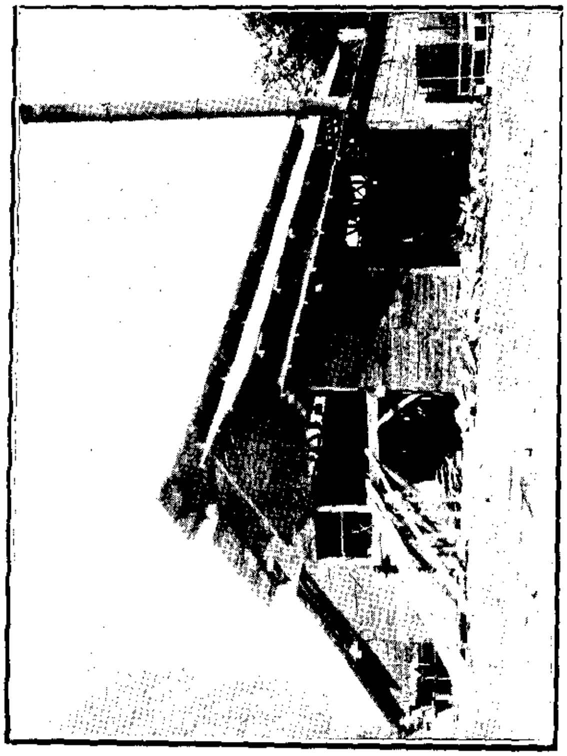


Fig. 2. Mill Premises (at rear).

Fig. 3. Part of the Workshop.

Fig. 4. Main Saw and Log Carriage.

Photos. by Lakhpat Rai, I.F.S.

under exploitation, and from which timber can be supplied to the mill, is some 10 miles distant from Allapilli.

Power for the mill is furnished by a 50 (N) H. P. double cylinder steam engine (by Ransome—England) and a Locomotive-type Lancashire boiler (by Garrett and Sons). The engine drives at present two circular saws and a travelling log carriage, a pendulum cross-cut saw and an edger. A workshop with saw sharpening machinery is also driven. The sawing machinery is all set up on a raised deck with the shafting and driving gear beneath. The whole mill is contained within a corrugated iron roofed open shed 100 feet long by 24 feet wide, with the engine and boiler at one side.

Wood fuel (mill refuse and sawdust) is consumed and the engine rests on a steel girder frame embedded in a concrete foundation 4 feet deep. Water for the boiler is pumped from a well nearby and flows into 3 storage tanks connected with the boiler feed. Diameter of the driving wheel of engine is 8 feet with a 22" wide face normally running at 100 r. p.m. and a 20" belt is used for the main drive. This belt running over a 3' 7' diameter pulley, on $4\frac{1}{4}$" shafting, gives about 200 r. p. m. Two circular saws and the log carriage are run directly off the main shaft, whilst other machines are run by means of counter-shafting.

The two circular saws are the saws mostly used. The main circular (54" diameter) is driven by a 16" belt at 500 r. p. m. It is fed by a 3-block carriage running on fixed rails, the forward and reverse motions of the carriage are controlled by a single lever. The second circular (36" diameter), fitted up on a plain table, made locally, is also driven off the main shaft but is fed by hand.

Logs are brought from the depôt at Allapilli and also from the forest by means of buffaloes and unloaded in the mill compound where a 2 ton hand crane is used for lifting the logs up to the log deck and they are then run on to the carriage of the main saw by means of 2 'Movies' blocks travelling on a steel girder. The carriage is provided with strong dogs for holding the log and also with set works for adjusting the cut.

The pendulum cross-cut saw hangs vertically from an overhead wooden beam and dead-rolls are used for running timber to and from it. The 'Tower' edger is also run from overhead counter-shafting. A saw sharpening machine is included in the workshop with a saw-sharpener always at work on the saws. The workshop machinery is driven by the main engine but a small 'Petter' oil engine has been installed which is capable, if required, of running the whole of the workshop machinery, thus rendering it independent of the main engine. It is used only when the mill is not working and it is found necessary to run the workshop for any reason.

The mill is largely engaged in cutting up a class of teak timber for which there is no sale when in the log, as it is mostly unsound and crooked. A considerable quantity of unsound timber had accumulated in the Allapilli depôt in past years and is now being put through the mill. Besides dealing with this timber a proportion of sound logs, supplied from the coupes under extraction, are also converted into squares, beams, posts, etc. Teak is the main species dealt with, but sometimes others are sawn to meet purchasers' requirements, *e.g.*, *Gmelina arborea* (*siwan*), *Ougeinia dalbergioides* (*tiwas*), *Bombax malabaricum* (*semal*), *Hardwickia binata* (*anjan wak*), *Terminalia tomentosa* (*ain saj*). As green timber is also handled, besides teak which has been seasoned in the log, a seasoning and storage shed 100′ × 40′ is now being constructed and is nearing completion. This is being built according to a design of the Bombay Forest Department.

Sawn timber from the mill is carted by country carts, to rail-head at Ballarshah, a distance of 62 miles, where there is a large Government timber depôt. Ballarshah depôt is also the main sale centre for all timber in the log (both round and rough squared) which is extracted departmentally in the Division. Auction sales are held here periodically by the Divisional Forest Officer and timber is also available for sale at any time, at this depôt.

The mill normally works six (8-hour) days in the week and

is closed down on Sundays. Outturn figures for the months of April and May 1925 were as follows :—

April.

97	teak logs yielded	2,524	cubic feet	of marketable sawn material in the form of squares planks, scantlings & battens.		
9	Siwan	do.	86	do.	do.	do.
7	Tiwas	do.	78	do.	do.	do.

May.

293	Teak	do.	2,430	do.	do.	do.
16	Siwan	do.	151	do.	do.	do.
24	Semal	do.	212	do.	do.	do.

(*N.B.*—During the above months some 140—150 tons of logs were passed through the mill and the outturn figures therefore are very low in comparison, but as a large proportion of the logs were unsound, high wastage was inevitable.)

Skilled labour is not available in Allapilli, which is a 'Forest Village,' and as the nearest town, Chanda, is 72 miles away it is found impossible to retain any sort of skilled labour in permanent residence at Allapilli. The establishment of the mill consists of a Manager in charge of the mill, with 16 employees under his control, the majority being local villagers.

The financial results of the mill have not been entered into here as the mill has only been working for a few months. There is sufficient power available to run several more saws, but the installation of further saws is being held in abeyance pending an improvement in market conditions. The local market has been in a very low state recently and the demand for sawn material somewhat poor in consequence. The lead from the mill to railhead is a long one and the method of transport now in use, *viz.*, bullock carting, although very slow, has been found to prove the most economical form at present. Unfortunately, the route is interrupted by the unbridged course of a river and during the rains carting operations have to be suspended. The advent of a new railway in the vicinity in the near future will, it is hoped benefit sales to some extent.

"SAWDUST"

SANTALUM ALBUM (LINN) IN THE CHITTOOR DISTRICT OF THE MADRAS PRESIDENCY.

ROOT-PARASITISM—IS IT OBLIGATORY?

Under the above heading two short notes were published by Mr. Fischer in the *Indian Forester* on pages 32 to 34 of January 1922 (Vol. XLVIII) and on pages 428 and 429 of August 1923 (Vol. XLIX). These were the interim reports of an experiment initiated by Mr. A. B. Jackson in 1919 on the Horsleykonda hill in order to determine (*a*) whether sandal was an obligatory parasite, (*b*) if so, up to what age it could live and thrive alone, (*c*) whether it could live when parasitic only on other sandal, and (*d*) whether sandal became "spiked" when parasitic on itself.

The experiment has been under observation now for 5 years and has reached a stage when definite conclusions can be drawn. I, therefore, venture to record them in this note.

I may recapitulate here for the convenience of the reader that a number of sandal saplings growing on a tank bund, built on a sheet rock, were completely isolated from all growth in September 1919, and the whole bund was kept clean-weeded ever since, so that the saplings might not parasitise on any other vegetation.

In June 1920 Mr. H. C. Bennett, Conservator of Forests, visited the place and recorded as follows:—"The experiment referred to in Mr. Jackson's note is being continued. The bund has been thoroughly isolated and is being kept clean-weeded. All sandal on it are flourishing."

Mr. Fischer visited the place in 1921 and took photos of the sandal plants under experiment. These were reproduced and published against pages 32 and 33 of the *Indian Forester* for January 1922. He then made his observation to the following effect:—"In May 1921 the saplings were perfectly healthy, their leaves of a bright colour and fresh in appearance. They have grown considerably in height for they are now, many of them at least, over 15 feet."......"So that after 20 months of isolation the saplings are quite healthy and show no signs whatever of 'spike'."

About July 1922, it was reported that the saplings under observation were showing signs of degeneration owing to the deprivation of hosts.

Mr. Fischer again visited the place in July 1923 and published his observations in the August issue of the *Indian Forester*. He wrote that the plants certainly had not the same healthy appearance, that the leaves were narrower and were not bright-green, and that many of the branchlets and twigs had dried up. He, however, disagreed that this condition was unquestionably due to deprivation of hosts of other species and attributed it mainly to the very severe drought of the previous year.

Since this observation of Mr. Fischer, I visited the locality four times: once about the middle of February 1924, a second time in May, then in August and lastly in November after the plants had the benefit of good monsoon rains. My last visit was particularly to see whether rains made any difference in their condition.

When I visited on 30th August 1924, I found a large number of the poles already dead, and about 30 of them in a dying condition with very scanty leaves. Two of the plants, however, had a fair amount of leaves, but their colour was pale. Even in spite of monsoon rains in November, none of those struggling for existence revived. Almost all the poles are now dead.

This experiment leads us to the conclusion that sandal *is an obligate parasite* and can manage to live when parasitic on its own kind so long as the host sandal can supply food-materials to its guest and subsist itself. This is only possible for a short period. Since, in this experiment, the whole group of sandal poles were entirely isolated from any other plants, they all lived for 5 years, managing to obtain their requirements from one another, and when no more can be got they all died gradually. Lastly, no "spike" was observed at any time in the progress of this experiment. This shows that whatever the cause of "spike" may be, deprivation of hosts of other species, or sandal being parasitic on its own kind, obviously, is by itself not one.

It would not be out of place to note here that in 1916, some experiments were started on the Javadis of North Arcot District, with the object of finding out whether sandal was an obligate root-parasite. The experiment consisted of isolating existing sandal trees by means of a trench 4′ deep all round the selected tree, and keeping the mound around them clean-weeded. After 5 years, one of the trees which was still struggling along and had not died, was uprooted by the Forest College and its roots carefully traced down. It was discovered that the rootlets of this struggling sandal had managed to form a few attachments to a root of *Chloroxylon Swietenia* which was growing some 40 feet away from the trench, but yet had sent one of the rootlets into the mound below the bottom of the isolating trench and the tree was thus managing to live on. A similar phenomenon was observed in another tree under experiment extracted some 2 years ago. This experiment was, therefore, not very conclusive, though the struggling condition of the trees under experiment indicated want of hosts.

In yet another experiment at Komattiyeri on Javadis, Mr. K. R. Venkataramana Iyer had cut deep trenches and on such isolated mounds, he sowed seeds of sandal and had some seedlings grown. When I was in charge of the District, I found one particular seedling of these was very badly struggling for existence. I found it had a very few thick, brittle, pale-leaves at the lower portion of the branch. It was stag-headed and buds were seen to be forming, but were not coming up. Evidently this was almost completely isolated and had not the supply of food-materials to push on its existence. I, therefore, then dug out a *Jatropha curcas* plant with its roots and planted it by the side of this seedling in the mound, when it was drizzling. This *Jatropha* took root and established itself, and when I visited the place a couple of months later, I found the sandal seedling had shot up a clean healthy branch of about 2 feet in height with plenty of leaves. This again proves that hosts are necessary for the growth of sandal.

SAIVID ABDUL QADIR,
District Forest Officer, Chittoor.

THE GENUS *SONNERATIA*.

In endeavouring to identify specimens of Sonneratia collected in Tenasserim wide differences have been noticed in the works dealing with the genus so that the name finally selected for a specimen depends largely on the flora used. None of the works consulted seem to be very satisfactory and some are altogether misleading.

One species *Sonneratia apetala*, Ham., with its 4-lobed calyx and large umbrella-shaped stigma and small fruit is very easily recognized and I exclude it from consideration in the following remarks.

As regards the remainder an undue emphasis is usually laid on the presence or absence of petals. This character is a very bad one to use especially in the herbarium. In the case of *S. alba*, Koorders and Valeton, Boomsorten van Java I, p. 201, say :—" This species is described by all authors as having no petals. We have, however, not found a single flower in which the petals were completely wanting. As they bear a great resemblance to the stamens it is very easy to overlook them especially in the case of dried flowers." This is also my experience, one can usually see the petals in the herbarium but failing in any instance to find them one cannot be sure that they have not fallen off or been passed over as filaments of the stamens.

Kurz in the Forest Flora of Burma and copying him many others, *e.g.*, Gagnepain and Guillaumin in the General Flora of Indo-China, state that the fruit of *S. alba* is supported by the sharply angular calyx, whereas in flower the calyx is said to be obscurely angular. A more or less angular fruiting calyx is found in *S. pagatpat*, Blanco of the Philippines, but I have not found it in any Indian specimens. An angular fruiting calyx is apparently shown in the crude drawing of *Mangium caseolare album* in Rumph., Herb. Amb. III, t. 73, but no great importance can be attached to this. Rumphius was blind when the plates were drawn so never saw them. In his description he makes no mention of an angular fruiting calyx and he states that the

fruits of *Mangium caseolare rubrum* and *album* are similar so that either both or neither should have an angular fruiting calyx.

The angularity of the twigs sometimes given as a character must be used with caution. In *S. caseolaris* the young twigs are more or less distinctly quadrangular as are the peduncles of the flower and fruit but the older twigs are mostly round.

The species of *Sonneratia* are mostly wide spread *S. alba*, Sm., is said to extend from Tropical Africa to Australia and *S caseolaris* as I understand the species, extends from India to the Philippines so that they naturally show a good deal of variation.

As *S. alba* and *S. caseolaris* are based on *Mangium caseolare album* and *rubrum* of Rumphius respectively it is necessary in the first place to try to interpret Rumphius' species.

In comparing the description given by Rumphius the following seem to be the main points on which the two differ :—

MANGIUM CASEOLARE ALBUM.	MANGIUM CASEOLARE RUBRUM.
Habitat. Littoral on hard and stony soil.	Habitat. Not littoral but found near the banks of the larger rivers.
Vertical respiratory roots very numerous, a span to 2 ft. long.	Vertical respiratory roots scanty and shorter.
Twigs round.	Twigs quadrangular.
Flowers green, 2-3 together, petals wanting.	Flowers red, solitary with petal.
Wood used in boat-building.	Fruit larger than in album, edible.

In addition Rumphius says that *Mangium caseolare rubrum* "*flagella emittat*" but what he means by this I cannot suggest.

It is evident that in the herbarium without good specimens these two species are difficult to distinguish. I believe the only reliable distinction between them lies in the fruit. This is the character used by Koorders, Exkursionsflora von Java II, p. 663.

It should be noted that Rumphius in an appendix mentions a form of *rubrum* with oblong leaves rounded at the apex 2½ English inches long by 1½ broad. This seems to be Miquel var.

mucronata. It is very easily distinguished from *S. alba* by the shape of the leaves which when dry are distinctly veined. It is the only form of the species which occurs in India. Another form *S. lanceolata* Bl., from Borneo and the Celebes according to Miquel, Fl. Ind. Bat. I, p. 1088, differs only from var. *mucronata* in the leaves being acute at the apex. This form according to Ridley, Flora of the Malay Peninsula I, p 825, is the only one found in the area he deals with.

In Tenasserim there are three species of *Sonneratia* which may be distinguished as follows :—

A. Flower-buds pointed.

Flowers solitary ; leaves elliptic or elliptic-oblong tipped with a small recurved mucro, nerves distinct ; petals conspicuous ; fruit 2 inches diameter or rather more, seated on the nearly flat calyx.

S. caseolaris (Linn.) Engl.
var. *mucronata* (Miq).

Flowers usually in clusters of 2—3 ; leaves obovate, obtuse, nerves obscure ; petals obscure ; fruit 1½ inches diameter or rather less, seated on and partly enclosed by the obconic or cup-shaped calyx.

S. alba, Sm.

B. Flower-buds obtuse.

Flowers in clusters ; leaves broadly elliptic or ovate or obovate, distinctly veined ; petals 0 ; fruit 2 inches diameter seated on the flat woody calyx.

S. Griffithii, Kurz.

S. caseolaris (Linn.) Engl. in Engl. und Prantl, Pflanzenf. Nachtr. I (1897), p. 261.

Rhizophora caseolaris, Linn. in Stickm. Herb. Amb. (1754), p. 113, ex parte.

S. acida, Linn. f. Suppl. (1781), p. 252.

Linnaeus based his *Rhizophora caseolaris* on *Mangium caseolare*, Rumph., Herb. Amb. (1750), tt. 73, 74 and 75. The species as here understood is the plant figured in t. 74 ; t. 73 is *S. alba*, Sm. whereas t. 75 is intended to show a moth on *Mangium caseolare rubrum* rather than the plant.

4

var. *typica*. This is the plant mainly described by Rumphius. As already noted it must be very similar to *S. alba*, Sm., but according to Miquel, Fl. Ind. Bat. I, p. 496, the nerves of the dry leaves are conspicuous. *S. obovata*, Bl. fide Koorders and Valeton, Boomsoorten van Java I, p. 199.

Habitat. Leytimor (Rumph.) Java not as common as the following form (Koorders and Valeton). I have seen no specimens of this.

var. *mucronata* (Miq.) var. nov. Rheed. Hort. Mal. III, t. 40. This form extends from Bombay (fide Cooke Fl. Bomb. p. 515) to the Philippines (*vide* Brown and Fischer Philippine Mangrove Swamps p. 38, t. 15, sub *S. alba*) *S. lanceolata*, Bl.

I have seen the following specimens :—

Wall. Cat. 3641 A, *ex parte quoad* herb. Calc.

Madras Herb. Calc. Godaveri Delta, *Foulkes* vern. *Pedda Kalingy* ; *Wight* 985.

Ceylon Herb., Calc., *Thwaites*, C. P., 1595.

Sunderbans Herb., Calc., *Kurz, Heinig* 41 vern. *ora*, *Gamble* 10085, 10119, *Prain*. Herb. Dehra *Lace* 2323, *Prain, Heinig* 3, *Gamble* 10119.

Burma Herb. Calc. Akyab *Rogers*, Pegu *Kurz*. Herb. Dehra *Po Tun* vern. *lamu*, *Mergui Parker* 2367.

Perak Herb. Calc. *Wray* 2494, *Scortechini*.

Johor Herb. Calc. *Collector unknown*.

Java Herb. Calc. *Koorders* 4448, 14217, 14218, 14219, 14253.

The flowers in this species are red. The fruit is smooth and shiny and the calyx in fruit leathery.

S. *alba*, Sm. in Rees Cyclop. 33 (1816) No. 2.

Mangium caseolare album, Rumph. Herb. Amb. (1750) t. 73.

Smith based his species entirely on Rumphius. Rumphius describes the plant from the Moluccas and the adjacent islands. It is figured by Klotzsch in Peters Reis. Mossamb. Bot. t. 12. There is also a small figure of the fruit in West Australia Forest Department Bull. 32. S. *pagatpat*, Blanco is doubtfully referred to S. *alba* by Koorders and Valeton l. c. p. 200. It is a Philippine species and judging by the description and figure given by Brown and Fischer (l. c. sub. *S. caseolaris*) as well as from speci

mens it is correctly quoted as a synonym of *S. alba*. *S. evenia* Bl. should also doubtless be added *vide* Miq. l. c. p. 1088.

I have seen the following specimens :—

Burma Herb. Calc. Mergui *C. G. Rogers*. Herb. Dehra Arakan *Pemberton*, Tavoy *Parker* 2202, Mergui *C. G. Rogers* vern. *lame*.

Andamans Herb. Calc. Parkinson 677, 1024, *Prain's collector C. G. Rogers* 16, *King's collector*, *Kurz*. Herb. Dehra *Parkinson* 275, 677, 1024.

Perak Herb. Calc. *Scortechini*.

Java Herb. Calc. *Koorders* 12162, 12534.

Moluccas Herb. Calc. *Teysman* Hb. Bog. 1771.

Philippines *Merrill* 1317, 215, *Elmer* 10455, *Loher* 5095.

New Caledonia Herb. Calc. *Pancher*.

The petals and stamens are white but the inside of calyx-segments is pinkish-crimson. The fruit is dull and slightly rough on the surface and the calyx in fruit leathery or almost woody.

S. Griffithii, Kurz in Journ. As. Soc. Beng. (1871) p. 56.

In the above reference Kurz gives only the characters that distinguish this species from *S. caseolaris* and *S. alba*. This is repeated in Pegu Report (1874) App. B., p. 54. The plant is described in greater detail in Kurz For. Fl., Burma, I., p. 527.

The type of this species is Griffith's specimens Kew Distrib. No. 2433, collected either in Mergui or Moulmein.

I have seen the following specimens :—

Burma Herb. Calc., *Griffith*, 2433, *Wallich* Cat. 3641. A *ex parte quoad* Herb. Calc. *S. rotundifolia*, Wall. Mss. Herb. Dehra *Po Tun* vern. *Laba*.

Bassein *Rogers* 48 vern. *Laba, langu, thatta*.

Maungmya *Lace* 2966 vern. *Laba, thatta*.

Amherst Herb. Calc. *Falconer* 944.

Tavoy *Rogers* 371 T, Herb. Dehra *Rogers* 371 T, vern. *Kabe*, *Parker* 2325 vern. *Laba*.

Mergui *Rogers* 415, M ; Herb Calc. *Rogers* 415 M. *Meebold* 14153.

Andamans Herb. Calc. *Parkinson* 1115, 1148. Herb. Dehra *Parkinson* 1115, 1148.

The flowers are greenish-white. Fruit much like that of *S. caseolaris* but roughish and not shining and the calyx much thicker and woody.

The Index Kewensis quotes *S. neglecta* Bl. as a synonym of *S. Griffithii*. If this were correct the former name would stand but according to the description given in Miquel, Fl. Ind. Bat. *S. neglecta* can hardly be the same as *S. Griffithii* and seems to be *S. caseolaris* in which the petals are either wanting or have fallen off. The plant moreover is supposed to have come from Ceylon where *S. Griffithii* has never been collected.

Although *S. caseolaris* is said to be a tree of the mangrove swamps it does not appear to be littoral. Rumphius as already noted states that the tree is not littoral but found on the banks of the larger rivers. In Tenasserim I found it far up the Tenasserim river where the water was probably nearly fresh though tidal and I did not see it near the sea where *S. alba* and *S. Griffithii* occur. This probably explains its absence from the Andamans. In the Malay Peninsula according to Ridley it is found on tidal rivers and in the Philippines it is found according to Brown and Fischer along the upper stretches of tidal streams.

S. alba is a littoral species often found on the open coast but also in muddy bays growing with *S. Griffithii*. Judging by small pieces the timber is better than that of the other species and somewhat heavier. Gamble, Man. Ind. Timbers, gives the weight as 42 lbs. per cubic foot against 31 lbs. for *S. caseolaris* though both specimens are quoted under *S. acida*.

S. Griffithii is as far as I have observed the largest species in Tenasserim and probably for this reason is the one used for timber. Rogers in the case of the Delta Reserves of Bassein notes that the tree is 60—70 ft. in height and 5—6 ft. in girth and is one of the best timbers in the reserves. I saw trees very much larger in girth than this but they were mostly defective. This tree has bigger leaves and is more umbrageous than the other species.

R. N. PARKER, I.F.S.,
Forest Botanist.

WORKING PLANS FOR SAL FORESTS IN THE UNITED PROVINCES.

As is probably known to all forest officers who are concerned with *sal* forests, most of the working plans in the United Provinces until recent years prescribed "Selection fellings." It would be hardly correct to call it "the Selection System" as the prescriptions and the results departed considerably from the text book idea of the Selection System. A few of the plans prescribed "improvement fellings" only and there were some forests under coppice-with-standards.

A departure from these methods was first made, mainly under the advice of Sir George Hart, in Collier's revised Working Plan for the Haldwani division (1914—1934) in which an attempt was initiated to convert the *sal* forests at the foot of the hills to the uniform system. Subsequent revisions of plans have followed the same lines with the important modification that regeneration by coppice has been made use of wherever possible.

Considerable variation of opinion having arisen concerning the soundness of this policy the subject was fully discussed at a meeting in Naini Tal and it is hoped that an account of the discussion will be of general interest. I think I cannot do better than append in full the memorandum drawn up by myself after the meeting. It should be understood that the memorandum does not pretend to represent the unanimous opinion of U. P. officers nor is it a majority or a minority report—it is rather a statement of the problem and a compromise which appears to me to afford the best means of carrying on until further knowledge is acquired.

F. F. R. CHANNER.

MEMO OF CONCLUSIONS ARRIVED AT BY THE CHIEF CONSERVATOR OF FORESTS CONCERNING THE STRUCTURE OF FUTURE WORKING PLANS FOR SAL FORESTS AFTER A MEETING ON 27TH JUNE, 1925.

PRESENT:—Messrs. F. F. R. Channer, E. R. Stevens, C. G. Trevor, F. Canning, J. Whitehead, A. E. Osmaston, E. A. Smythies, V. A. Herbert and J. V. Collier.

1. The meeting was held primarily to discuss the opposition felt by several officers to continuing the shelterwood compartment (or P. B.) system prescribed in recent Working Plans.

2. The opposition may be said to arise very largely from a misunderstanding, *viz.*, that the shelterwood compartment system *demands* (1) that heavy fellings must be made in mature forests with no established regeneration both because the prescribed yield must be removed from the compartments in P. B. I within a limited period and because the system claims that regeneration will follow such heavy fellings. There is a strong feeling that some such fellings which have been made have owing to weeds lessened rather than increased the prospects of natural regeneration; (2) the production of approximately evenaged crops over whole compartments.

It is felt that since there are so many existing compartments in which a substantial proportion of the crop does not belong to the age period in which it is placed, either there must be much unnecessary sacrifice of groups of immature trees and probable failure to get regeneration under them or the system stultifies itself by asserting that an approximately evenaged crop has been produced when the resulting variation in age may be as much as 1 to 80 years.

3. To revert to (1) There is no reason why heavy fellings which are felt to be silviculturally unjustifiable or doubtful should be made under the P. B. system. It will rest with the D. F. O. controlled by the Conservator to make fellings only of such intensity as is thought desirable and to try in the meantime any order means (such as fire) for inducing regeneration.

As regards not obtaining the prescribed yield it is highly unlikely that it will not be obtained in the first ten years, because the regeneration of certain areas is difficult. After 10 years it will be revised and the revision will not only take into account that regeneration is deficient in some areas but more suitable areas can be passed into P. B. I. Even supposing a fixed P. B. system, and that at the end of the period the prescribed yield has not been removed it simply means that we have been going too fast and there must be a hiatus; exactly the same would happen under the Selection System if regeneration does not come in. We should find the prescribed number of mature stems (or volume) could not be taken because the removal of the trees was unjustifiable silviculturally.

4. To revert to (2) the P. B. system regards approximately evenaged crops over whole compartments as the ideal for the reasons that (*a*) *sal* being a light-demander the larger the groups the less the damage done to regeneration by the shade of surrounding trees, (*b*) exploitation is facilitated.

The system aims at utilizing the fact that *sal* tends to grow in evenaged crops over considerable areas rather than under true selection conditions. Where this tendency is an obvious fact it would be useless to continue the selection system. Where the tendency is contradicted by the facts the system is quite content to obtain evenaged crops in groups of such size as can be obtained without undue sacrifice or any attempt to combat nature and to admit that evenaged crops by compartments have not and perhaps cannot be achieved. It might, therefore, be better to emphasize this point by ceasing to talk of the Shelterwood Compartment system and call it the P. B. system.

5. It may be admitted that when six periods of 20 years were laid down there may have been some ground for apprehensions that in the effort to obtain results within too short a period some bad silviculture would take place, but by the extension of the period to 40 years it may reasonably be expected that the system will not fall far short of its aims. All officers are by no means equally pessimistic of the future of the heavily felled areas

which have been criticized and hold that within the 40 years success may be counted on. In other words it may be found that by suitable selections of areas for P. B. I, crops evenaged to the extent of a 40 years difference between the youngest and oldest tree will be established but if reasonable silviculture demands that groups 60 or 80 years old be left when the areas pass out of P. B. I, they will be left.

6. It is thus seen that so far as varying opinions are due to differences about silviculture, no objection to the P. B. system arises. On the other hand a P. B. frame work to a plan has certain manifest positive advantages :—

(1) The most important of all I think is that obtaining regeneration which is the problem before us, is attempted in certain definite areas and (if the Working Plan is well made) in the areas in which it is most needed. Care must always be taken not to select only the areas in which regeneration appears easiest. These areas will remain constantly under observation and be subject to every kind of endeavour and experiment. It is even more important to be able to observe closely where and why we *fail than to observe where we succeed.*

(2) By working as far as possible by large groups we make firing as an aid to regeneration possible.

(3) Tending of established regeneration is assured.

(4) All silviculture is easier when one knows what one is aiming at. For example if an officer is told in a given crop of mixed sizes to do the best silviculture he can, the best will depend on whether he is aiming at regeneration or at increasing the average girth of the crop. That is a point which the Working Plan and not the D. F. O. should decide.

(5) The scope for obtaining regeneration is much increased by abandoning a rigid girth limit under which trees may not be felled (except under improvement fellings). Permitting sacrifice of immature trees has led to the development of regeneration by coppice over whole compartments in Dehra and Ramnagar to the great advantage of the ultimate value of the forests.

(6) Enumerations which are very expensive especially if repeated every 10 years are reduced by two-thirds.

7. The old selection methods had none of these advantages. They profess to and to some extent do favour regeneration in groups wherever it is found but the system as practised was largely selection by single trees and was often forced to be so because of the girth limit. It has been said that the crops which have given us the large yields of recent years grew up under the selection plans but it might be more true to say that they arose from the heavy fellings prior to regulated management. The system entirely ignored the most fundamental fact about *sal*, namely that it is a light demander and that it is not suited to the true selection system. Again, it was a great error of the old system that too often the supposed young trees left for the future after a main felling were really suppressed trees of considerable age which could never develop a normal increment. In short the P. B. system can do all the selection system could and a great deal more.

8. A word may be said here about what is called "Clutterbuck's" system.

This consists of basing the yield on the whole forest and carrying out the most suitable silviculture at every point in turn. *In theory* it meets every objection that can be raised about unsuitable silviculture under the more rigid P. B. system but it has the serious drawback that advantages (1), (2), (3), (4) and (6) of the P. B. system to a great extent disappear.

They can be replaced by the Working Plan Officer selecting certain areas (say 1/3) for definite treatment but there is little or no practical difference between this and the P. B. system as expounded above.

9. Finally it may be noted that opposition to the P. B. system sometimes takes the form of objecting to prescribing that certain areas shall be treated in a certain way because not all the crops in those areas will lend themselves readily to such treatment. For instance, at the meeting it was suggested that discriminating between P. B. II and III is a mistake. This resolves itself into the question of whether a Working Plan is to lay down anything at all or merely to generalise and leave it all to the D. F. O. We have tried laying down too much as with 6 P. Bs. and too

little as in Howard's Ramnagar plan with only a P. B. I and a not P. B. I. It may be all right in theory for the D. F. O. to do his best everywhere on certain general principles but in practice those principles are found to be too vague and he does not know what to do or what is wanted. This has greater force if the capacities of the average marking officer are taken into account.

10. *I consider then that the fixing of* 3 P. Bs. with a 40 year regeneration period is the best compromise we have arrived at yet for the framework of a plan and that no silvicultural objections thereunder need arise.

11. This being decided on, the question arises of the treatment of the older crops which must occur outside P. B. I under a conversion system. On this question differences of opinion are more fundamental and cannot be said to be due to misunderstandings or expressing the same ideas in different ways.

One opinion holds that there should be regulated selection fellings outside P. B. I and the other that there should not. In theory there can be no doubt that there should not, because selection fellings are regeneration fellings and P. B. I has been selected for regeneration and its yield has been based on the idea of those being the only main fellings. Against this it is argued that under conversion the conditions are abnormal and that allowance must be made for mature crops which will deteriorate before they can come into P. B. I.

Personally I am of opinion that this danger is exaggerated because (1) it can largely be met by judicious selection of areas for P. B. I.

(2) Decay mostly sets in early in life owing to frost damage: trees of say 5–6″ girth which are sound now will not be unsound in 40 years time: trees which are unsound now will not be worth less in 40 years.

(3) The theory of a tree earning more increment as cash in a bank than growing in the forest is economically untenable nowadays.

Also there is a practical drawback *in the danger of such* fellings deteriorating into revenue fellings and for that reason in the Dehra Dun plan the selection is left to the D. F. O. The

Conservator objects that this is not a practical proposition but it seems to me that when the D. F. O. inspects his markings he should be able to deal adequately with any compartment which does present this problem on a serious scale.

12. In view however of considered opinion in favour of such selection fellings it was decided that the Kalagarh Plan which is the one immediately under consideration shall include selection fellings if the conditions which give rise to the demand for them are found to exist. Trees over a certain diameter which would not be removable under the usual intermediate fellings by area outside P. B. I may be removed under selection fellings, not with the object of obtaining regeneration but to avoid loss by deterioration.

The extent of these selection fellings will be regulated by fixing a diameter limit which will guarantee that the average diameter of the crops in P. B. II will not be unduly reduced.

The regulation of such fellings in P. B. III presents more difficulty because the period before entering P. B. I is 80 years but as a rule they should not be necessary in P. B. III because mature trees likely to deterioriate will mostly come out in any case under removal of existing overwood and if sufficient compartments fulfilling the conditions of P. B. III are not found it will be better to have an incomplete P. B. III. It is very important to avoid what are really heavy regeneration fellings under the name of removing remaining over wood.

F. F. R. CHANNER,
Officiating Chief Conservator of Forests, U. P.

DEVASTATION OF THE CHANGA MANGA PLANTATION BY FUNGUS ATTACK.

The Changa Manga plantation is situated in the Punjab plains about 40 miles south of Lahore, and is dependent on canal irrigation for its maintenance. Its formation was commenced in 1866 with the object of providing a supply of firewood for the use of locomotives on the N.-W. Railway and it was completed in 1880, the total stocked area being approximately 10,000 acres and

the crop consisting of *shisham* (*Dalbergia Sissoo*) raised from sowings by the trench and ridge method. Prior to its formation the land was semi-desert "rakh" land supporting a sparse growth of *jhand* (*Prosopis spicigera*), *wan* (*Salvadora oleoides*) and *karil* (*Capparis aphylla*). Felling operations commenced in 1881-82 under the system of coppice-with-standards and the first rotation of 15 years was completed in 1896-97, the crop at the final fellings consisting of a pure crop of *shisham* seedling trees. After the fellings the regeneration areas became rapidly invaded by mulberry from seed brought into the plantation by the canal water and birds, so that the crop felled during the second rotation of 21 years from 1897-98 to 1918-19 was a mixed crop of *shisham* coppice and mulberry seedling trees. The third rotation commenced in 1919-20, the crop at the final fellings consisting of an almost pure crop of mulberry, partly of coppice and partly of seedling trees.

The presence in the plantation of a deadly parasitic fungus (now known as *Fomes lucidus*) which attacked the *shisham* trees was known many years ago. As early as 1886 D'Arcy remarks in para. 35 of the Working Plan "a considerable number of trees are blown down annually, and such windfalls are, as a rule, found to have their roots dead and rotten even at the early age which the trees have attained at present. The percentage of windfalls however on the whole is not high, and it is a remarkable fact that standards even in the first year of their isolation, suffer but little from storms." Again in the Working Plan for the second rotation written in 1896 Hoghton remarks in para. 18 as follows: "It was also found that a good many trees were attacked by a fungus just above the soil surface. Trees thus attacked appear to be the most liable to be blown over. Specimens of the fungi, attacking the *sissoo* standards of which there are two or three varieties have been collected and sent to Dehra Dun for identification." From this date onwards the steady and rapid spread of the fungus attack of the *shisham* trees has become more and more apparent, and twenty years later in 1916 the author of the Working Plan for the third rotation remarks in para. 10 "The root parasite *Fomes lucidus* has spread very considerably in recent years and it can be found in almost every compartment and as

already mentioned it has exterminated *sissoo* in parts of compartments 66, 67 and 68 which have not been felled yet." The same author also remarks in para. 16 " of one thing the writer is convinced and that is that the fungus attack cannot go on very long at the present rate for there will be no *sissoo* to kill, the only hope for the *sissoo* is that the damage will probably become much less as the proportion of *sissoo* diminishes and the facilities for the spread of the fungus under ground become less."

In the years 1920-21 and 1921-22 there was severe drought, and shortage of water in the canal for irrigation of the plantation, many compartments receiving practically no irrigation during these two years. As a result of the drought it was reported that the mulberry crop had suffered severely, a large number of trees having completely died and many others having their crowns partially dead.

A somewhat similar result appears to have been experienced in 1914-15 for in the Working Plan for the third rotation written in 1916 it is stated in para. 13 "occasionally the irrigation arrangements do not work smoothly and this results in late irrigation of some parts of the plantation. When this happens in a hot dry year such as in 1914-15 crops which receive their watering late in the season suffer. Some compartments did not get water till late in June 1915 and in them the mulberry particularly suffered. The damage may have been due in part to unusual heat since a few mulberry trees and many *toon* trees were seen suffering apparently from drought even though standing near irrigation channels constantly in use."

The writer visited the plantation in January 1924 and although the trees were then in a leafless condition the appalling extent to which the crop had been affected was easily recognisable by the large number of dead fallen trees which littered the ground in almost every compartment. In some compartments the mulberry had died over quite large areas with little remaining in them except the *shisham* standards many of which had partially dried crowns.

The plantation was again visited by the writer at the end of March 1925, and at this time the mulberry trees were in full leaf

so that the extent to which they were affected was much more readily recognisable, and it was found that in addition to the dead and fallen trees a larger number had partially dried crowns. A feature which soon became apparent was the fact that the affected trees were either isolated or in groups of small or large extent, and that the trees surrounding the affected groups appeared unaffected. This characteristic feature which was everywhere noticeable made it difficult to understand how the damage could be attributed solely to drought. It was therefore decided to have a number of the affected trees felled and the stumps grubbed up and the roots examined. It was found that in every case the trees were attacked by a parasitic fungus, the presence of the fungus being detected by the roots being partially rotten, the rot frequently having extended also into the stem. After making a thorough investigation into the matter the conclusion arrived at was that every affected tree was a fungus attacked tree, and that not a single sound tree had been killed or seriously affected by the drought.

It was next decided to examine the coppice in the compartments felled during the current rotation, for it was concluded that coppice from the stools of trees which were fungus attacked at the time of felling could not be expected to survive for many years. On examining compartment 1 which was felled in 1919-20, and which was notorious for the extent to which the *shisham* standards had been attacked by fungus, it was found that the compartment was a patchwork of dead and dying groups of mulberry coppice. Even in compartments more recently felled and consequently with coppice of a younger age, there were visible signs of much of the coppice being affected, and in a compartment of coppice of only one year's growth, a clump of dead coppice was found and much of the other coppice appeared to be in a sickly condition.

It was also discovered that mulberry trees with broken down crowns, a conspicuous form of damage which had been observed from the early days of the plantation and had been always attributed to damage solely by wind, were fungus attacked trees, and that the crowns had broken at a weak spot caused by rot in the

stem. With regard to the subject of damage by wind the Working Plan for the third rotation written in 1916 states in para. 14 as follows "wind causes a good deal of damage, especially in crops which have recently been irrigated. Fallen trees occur in such numbers that it is not possible to collect more than a portion of them and many valuable stems are left to rot on the ground. It is not correct to assume that all the windfall is due primarily to wind, as in the case of *sissoo* standards it is usual to find that they have first been attacked by fungus and have only fallen after their roots have become rotten. In the case of mulberry much of the windfall and windbreak is due to the very dense state of the crop. The trees have been so drawn up by close growth that they cannot stand without the support of their neighbours and consequently once the wind gets into such a crop extensive windfall results. At the time of preparing descriptions of compartments it was noticed in many places in very dense mulberry crops 12 year old that at least half of the crop had *been blown down and many compartments which had been* densely stocked were tending to become very open. It is hoped by periodic thinnings to prevent most of this damage."

It is now clear that the whole of the damage to the mulberry crop previously attributed solely to wind is the result of fungus attack, and that no sound trees are overturned or have their crown broken by wind.

Another form of damage characterised by the drying and peeling of the bark of mulberry trees which has previously been attributed to blistering by sudden exposure of trees to the sun, has been also discovered to be due to fungus attack, the bark drying and peeling as the result of destruction of the cambium by fungus. In the early stage of this form of damage the bark dries in a narrow longitudinal strip extending more or less from top to base of the tree.

Besides partially dry crowns, broken down crowns, and blistering of the bark, other symptoms of fungus attacked trees are a black discolouration in the surface of the bark, which may be an early stage of the blistering of the bark, and also a

reddish-brown discolouration on the surface of the bark often in the form of a resinous encrustation.

In addition to *shisham* and mulberry, other species such as *bakain* (*Melia Azedarach*) and *toon* (*Cedrela Toona*) appeared to be attacked by parasitic fungi for many trees of these species were found to be dead or dying.

Sporophores of *Fomes lucidus* the well known parasite of the *shisham* trees were found growing parasitically on several green standing mulberry trees which had partially dry crowns. Sporophores of two other species of parasitic fungi were also found on both green standing *shisham* and mulberry trees.

The conclusions arrived at may be summed up as follows :—

(i) All the dead and dying trees (with the exception of those obviously killed by suppression) are trees attacked by a parasitic fungus.

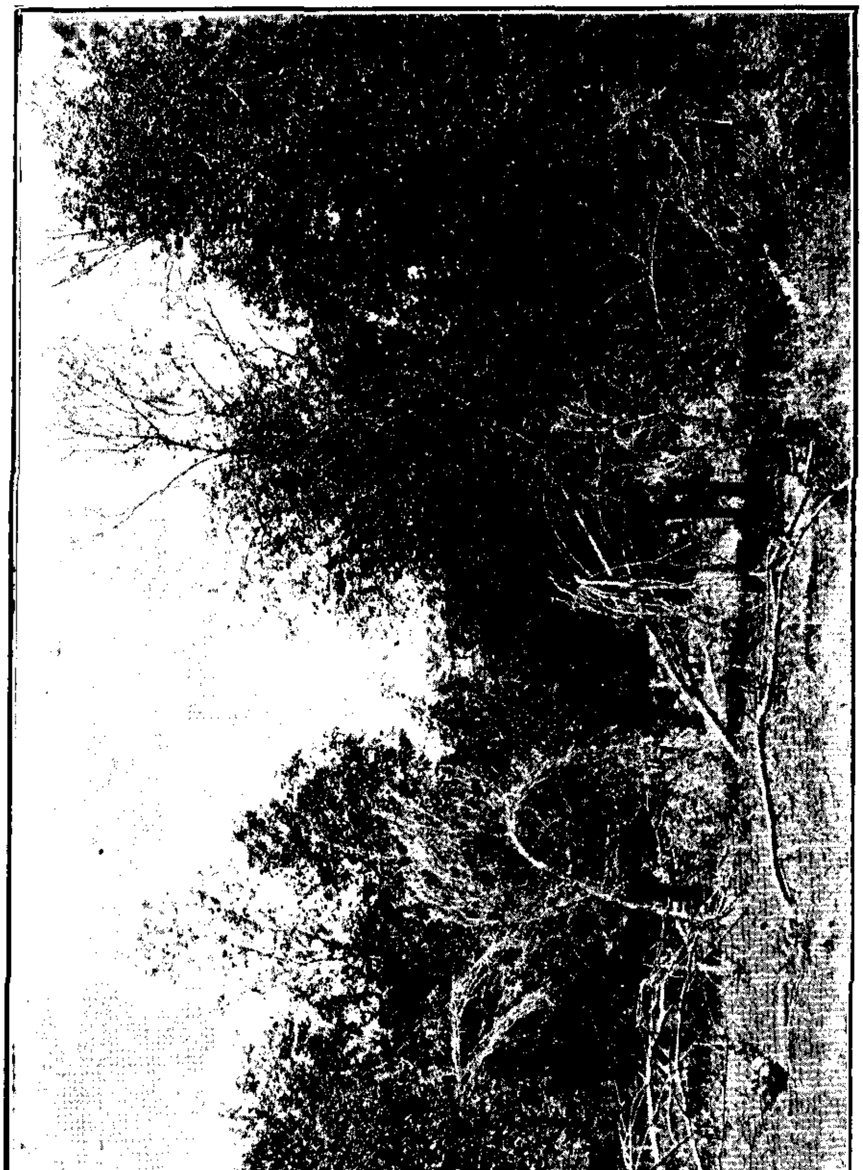
(ii) The drought has not caused the death of or seriously affected any sound tree, but has accelerated the drying up of fungus attacked trees owing to their roots being partially destroyed.

(iii) No sound trees are blown over by wind or have their crowns broken by wind with very few exceptions if any. The trees blown down are those with rotten roots due to fungus attack, and similarly the breaking of the crowns is the result of fungus attack.

(iv) The damage in the form of blistering of the bark previously attributed to exposure to the sun is a symptom of fungus attack.

(v) Both seedling trees and coppice trees of both *shisham* and mulberry are attacked by *Fomes lucidus*, and two other species of parasitic fungi. Other species such as *bakain* (*Melia Azedarach*), *toon* (*Cedrela Toona*) are also attacked by parasitic fungi.

(vi) The mulberry trees have been subject to attack by the parasitic fungi from the earliest days when it appeared in the plantations, simultaneously with the attack of the *shisham* trees.



Changa Manga. Dead mulberry trees killed by fungus attack April 1925.

Photo. by B. O. Coventry I.F.S.

In consideration of the widespread nature of the fungus attack and the fact that the coppice trees form infected stools cannot be expected to survive through a complete rotation, it is clear that the plantation has reached a phase in its life history when it can no longer be relied upon to yield a satisfactory outturn by regeneration from coppice and that consequently a revision of the present method of treatment is necessary. The most satisfactory method of regenerating the plantation which suggests itself is the "*taungya* method," by which the regeneration areas after the final fellings would be cleared by burning of the brushwood, removal of the stumps, the ground levelled and then put under the cultivation of field crops for a period of at least two years, a forest species being introduced by sowing or planting and grown in combination with the field crop during the second year Unless regenerated by some such method, the plantation will steadily retrogress to a plantation of *kana* grass.

It is a most remarkable fact that although the attack of the *shisham* trees by parasitic fungi had been observed from the earliest days of the plantation, the mulberry has been considered to be immune from attack by parasitic fungi up till the present time in spite of the fact that there is overwhelming evidence to show that it has been subjected to the same attack from the earliest days when it appeared in the plantation.

The plantation affords a most interesting example of the gradual annihilation of a forest by fungus attack and, it is to be hoped that the experience gained will not be lost sight of with regard to the future management of the new irrigated plantations now in the course of formation.

B. O. COVENTRY, I.F.S.

REVIEWS.

WOOD DISTILLATION.

THE TECHNOLOGY OF WOOD DISTILLATION, by M. Klar. (Translated by A. RULE, D. SC.)

Chapman and Hall, Ltd., London, 1925, *pp.* 496, *Price* 25*s.* The reprint of the second edition of this book gives a description of all well known processes used in the destructive distillation of wood and the recovery of bye-products up to the beginning of the War. Very little matter dealing with methods of manufacture has been added, primarily because it is not necessary and secondly on account of the difficulty in obtaining it.

As it stands, the work is the most up to date and thorough of its kind. The author has with great cleverness described cleverly and concisely the scientific principles underlying each process and has worked out logically the natural sequence in terms of apparatus. It is doubtful, indeed, if fault can be found with the work since there is no one as familiar with the subject as the author, but the arguments are all exposed for those who like to try.

Whether one be chemist, engineer, manager or merely an interested layman, the book will most certainly be found interesting and instructive and should form part of every technical library.

The translator has had no easy task but has accomplished the work with remarkable skill adding a good deal of interesting and useful information as well.

Not the least interesting part of the work deals with the cost of manufacture by different methods, all the figures are of course pre-war, any attempt at bringing them up to date could only have resulted in chaos as conditions are even to-day by no means settled. They serve however as excellent guides and go to show where things sometimes go wrong in the works.

The chapter on distillation and rectification is especially good and may be read with profit by anyone interested in the subject.

J. H. WARR.

THE FORESTS OF TEHRI GARHWAL.

THE ECOLOGY OF TEHRI GARHWAL; A CONTRIBUTION TO THE ECOLOGY OF THE WESTERN HIMALAYA, by W. DUDGEON and L. A. KENOYER. Journal of the Indian Botanical Society, April 1925.

After describing the topography and geology in some detail several pages are devoted to a study of the factors influencing and determining the vegetation. Precedence is naturally given to the climatic factors which determine the great climax types of vegetation. Next in order of merit are placed the edaphic factors dependent on the direction and precipitiousness of slope, depth of valleys, dip of the rock strata, physical characters of the substratum, and the activities of the larger streams. In reviewing these factors and their influence on the forest vegetation the authors are led to the conclusion that the *Pinus longifolia* and *Cedrus Deodara* forests are not true climatic climaxes but are what G. E. Nichols calls edaphic climaxes. Such a climax is held to exist when certain edaphic factors operate to maintain the vegetation permanently below the general climatic climax for the region. In the case of the *chir* and deodar forests the determining factor is believed by the authors to be scarcity of soil water due to physical conditions. With these conclusions I cannot entirely agree. If the average gradient of the slopes, the nature of the underlying rock and the physical characters of the soil in *chir* forests be compared with those found

existing in any adjoining forest climax such as *Quercus incana* or *Quercus semecarpifolia* I do not believe that such a comparison would show any marked differences. But if my point be admitted and if it is decided to use these edaphic factors as grounds for considering the *chir* forest as an edaphic climax, then it would be only logical to reason in the same way that the *Quercus incana* and *Quercus semecarpifolia* forests are also edaphic climaxes. In an article in the Journal of Ecology for 1922, entitled "Notes on the forest communities of the Garhwal Himalaya," I had also expressed the opinion that the *chir* forests were perhaps not true climatic climaxes and the reason I then gave was that this type of forest is only kept in stable equilibrium by the action of periodic fires which are the result of biotic influences. I am still of opinion that if this type of forest is not to be regarded as a climatic climax this view should rather be based on the theory of the comparative immunity of this species to damage by fire than on any exceptional dryness of this soil peculiar to the *chir* forests themselves. It may however be fairly acknowledged that fires are likely to produce dry soils and *vice versa* dry soils are likely to encourage fires.

The authors then pass to a description of the vegetative types. Three horizontal climatic zones are recognised, namely—

(*i*) Tropical, up to 5,000 feet with 80 to 90 per cent. of the precipitation during the summer; a warm dry autumn and spring and cool winter with little rainfall.

(*ii*) Temperate, 5,000 to 11,000 or 12,000 feet with 70 to 80 per cent. of the precipitation during the summer; shorter and more moderate spring and autumn, and a cool winter with considerable snow.

(*iii*) Alpine, above 11,000 or 12,000 feet with short rainy summer, a brief spring and autumn and a long cold winter with heavy snow fall.

The following three vegetative zones are then recognised as corresponding with the climatic, *i.e.*—

(*i*) Monsoon forests in the tropical zones, determined mainly by the monsoon and deciduous during the hot dry season.

(*ii*) Broad-leaved sclerophyll forests in the temperate zone determined by a truly temperate climate and dominated by oaks.

(*iii*) Alpine forests and formations above timber line in the alpine zone, the forests being coniferous and winter deciduous.

Under each of these main groups several climax communities are recognised and described in some detail. The descriptions are generally good but though attempts have been made to indicate the stages of succession leading up to the climax it must be admitted that information on this important subject is still very meagre. In reading through these descriptions I have selected certain statements regarding which the following critical remarks may perhaps be of interest :—

Shorea robusta forest.—The statement on page 250 that the *sal* forests are "rather dense with comparatively little undergrowth" is not a definition which can be applied to all types of *sal* forest. Some have dense undergrowth. Again in a discussion of the distribution of this species we read "as the great river valleys are at so low an altitude for only short distances back in to the mountains, the *Shorea* forests do not extend back very far from the plains." The authors therefore consider that the rising elevation of the river beds accounts for the absence of *sal* from the central and inner valleys. This explanation though plausible at first sight is incorrect since the great river valleys rise remarkably slowly. For instance the Ganges valley is below 2,500 feet elevation at Karnpryag and yet *sal* is not found beyond Byansghat which is about 100 miles lower down. Similar conditions exist I believe in the Sarda and Jumna valleys. The true explanation of the limitation of *sal* is probably to be found in the change which occurs in the outermost hill ranges from the tertiary sand stones and conglomerates to the very different rocks of the Purana group. This explanation was I believe originally put forward by Mr E. A. Smythies.

Pinus longifolia forest.—On page 253 the authors state that *Pteris aquilina* is a characteristic species of these forests. This is contrary to my experience in British Garhwal where this fern is more characteristic of the oak forests.

Quercus incana forest.—On page 257 it is stated that *Pieris ovalifolia* is evergreen. So far as I have observed this species is always deciduous. Again on the same page the authors state that they have nowhere found this forest exempt from the ravages of man. Now such a statement may be capable of several interpretations, but I am left with the impression that there are no *banj* oak forests in the Tehri State that have not been badly damaged by lopping or felling. Such an interpretation is not I believe quite in accordance with facts. I have worked all along the western border of the State where it marches with British Garhwal north of Rudra-pryag and I have seen some fine *banj* oak forests there within the Tehri border which were almost undamaged. There are of course in British Garhwal quite extensive areas of *banj* forest which are practically virgin.

On page 259 the following species are given as representatives of the pioneer stages, *i.e. Acer oblongum, Machilus Duthiei, Litsæa consimilis, Cornus capitata, Ilex dipyrena, Celtis australis, Betula alnoides* and *Ulmus Wallichiana.* Whilst the following are given as pioneer species in the higher formations (presumably *Q. dilatata* and *Q. semecarpifolia* are meant), *i.e., Acer pictum, Populus ciliata, Juglans regia* and *Carpinus viminea.* The authors then go on to state that in my note already quoted I have considered these forests which they call pioneer to be climax communities, and in support of their view they contend that the oaks give the impression of being invaders in such forest types. It is in the accuracy of this observation that the whole crux of the situation lies and I confess that it does not agree with my own observations. These miscellaneous broad-leaved species occupy or tend to occupy the lower levels of the larger valleys and ravines, usually on shaded aspects. And here a very important climatic factor has possibly received insufficient attention I refer to the strong currents of cold air which blow down all the larger ravines at night time throughout the greater portion of the year. It is moreover surprising within what narrow altitudinal limits these cold air currents operate so that at an elevation of only a few hundred feet above the bottom of the valley the night temperatures may be considerably higher than at the bottom of

the valley itself. It is hardly possible for anyone who has not experienced the cold winds which blow down the valleys in higher mountain regions to realize how persistently they operate and what a far-reaching effect they may have on the forest growth. I am therefore strongly of opinion that the miscellaneous forest types we have been discussing are climatically climax forests because of these very local but peculiar conditions of night cold which exist where these types are almost exclusively found.

Quercus semecarpifolia-Abies Pindrow forests.—On page 263 *Rosa Webbiana* is mentioned as a common shrub in this type of forest but I venture to suggest that the authors have mistaken *R. macrophylla* for this species as *R. Webbiana* is only typical of much dryer types of forest and in my experience is never found in *Q. semecarpifolia* or *A. Pindrow* forests.

Cedrus Deodara forest.—On page 268 the authors try to explain why this species does not extend further eastward and they give as their first reason the increasing rainfall as you pass from west to east. This in my opinion is a correct and sufficient explanation. The authors however add as an additional reason the physical barrier offered by the mass of lofty mountains to the north of Naini Tal. In the first place this argument is pointless in view of the fact that deodar has been reported from Nepal. But apart from this the comparative ease with which coniferous seed can be spread by seed-eating birds such as Nutcrackers and Grossbeaks I think effectually disposes of the view that a short stretch of mountainous country could prove a barrier for long were other conditions favourable.

Having completed the description of the various types of forest, the influence of man on the vegetation is discussed in some detail. Readers of the *Indian Forester* will doubtless recollect that Mr. H. G. Champion has already enlarged on this subject in two articles contributed in 1923, and this subject seems to me to have been rightly given the prominence it deserves. In discussing the combined effect of the various human factors the authors affirm in no uncertain manner that most of the barren hill sides in the continuously inhabited area of Tehri State are he results of human interference super-imposed on difficult

edaphic factors, and that when once the original climax vegetation is destroyed natural recovery is permanently prevented. All who know the conditions will doubtless agree with these conclusions.

The article is illustrated by maps and 14 photographs representing different aspects of the forest types described. The photographs are unfortunately rather poor and they have not been improved in the process of reproduction.

A. E. OSMASTON.

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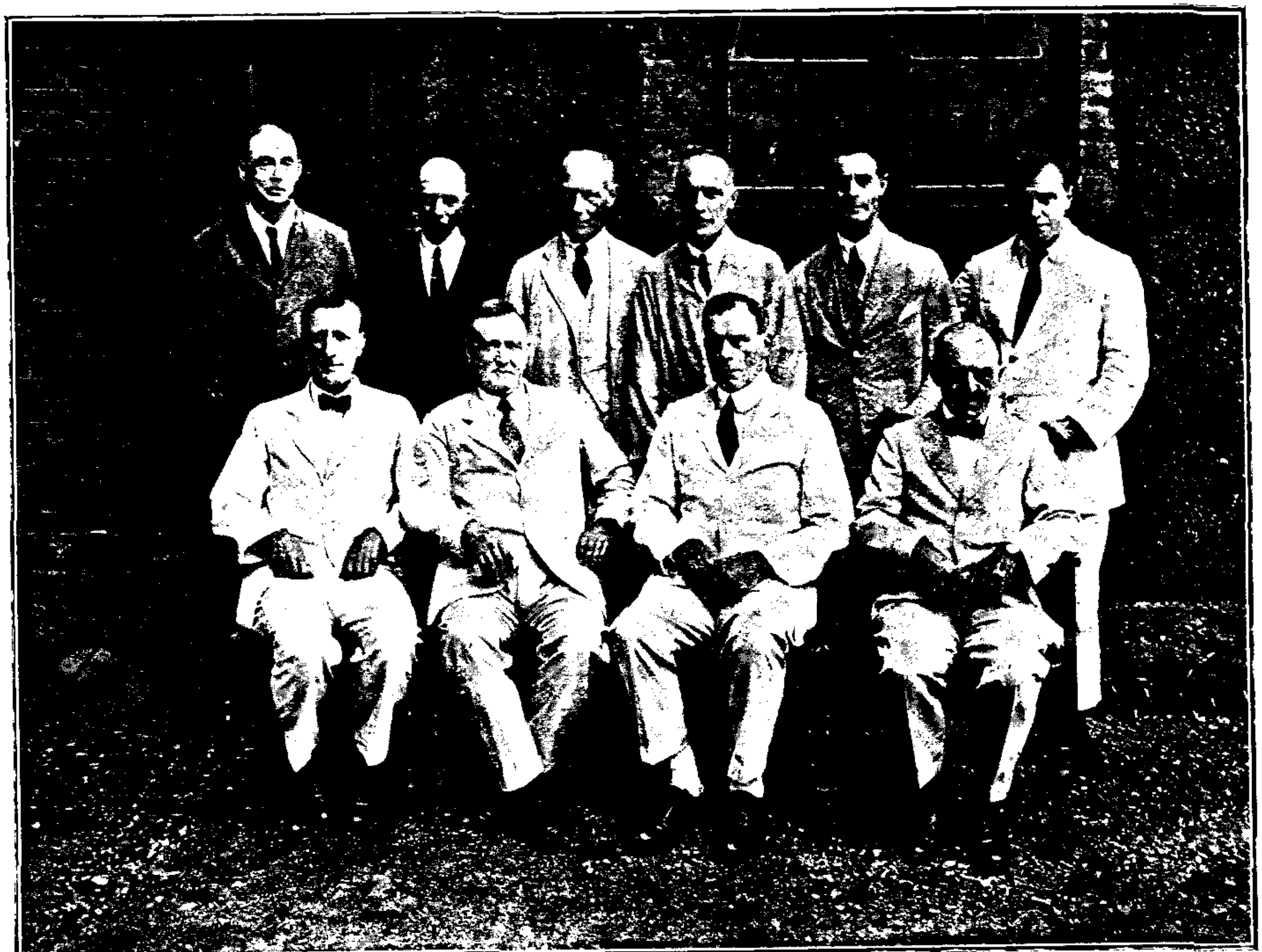
THE SUCCESS OF THE PATRIATA ROPEWAY.

A full description of the plant of the Patriata Ropeway, Punjab, with detailed drawings and specifications of parts was given by Mr. H. M. Glover in the October 1913 number of the *Indian Forester* (No. X, Vol. XXXIX), but the history of the installation since that date may be of interest to those forest officers who meditate a similar venture, while the statistics showing its value would form an excellent bit of propaganda in persuading local politicians of its worth.

Description.—The Ropeway is of the moving cable type, as opposed to the fixed cable and moving tractor rope of the "Donald" and other types of aerial transport. The bucket carriers are slung from "boxheads" consisting of an arched clamp in which an internal diagonal ridge bites on to the hollow between stands of the cable; this clamp may be likened to the upper half of a rifle barrel in which the rifling forms the ridge. The bucket thus remains poised stationary on the moving cable, until it reaches a terminal or angle station, where it is switched from the rope on to an overhead guide rail. This guide rail at the terminal station is flask-shaped and leads the bucket round to be picked up by the returning cable for the home journey (*vide* Fig 1., Plate 30). Two small trolley wheels are so fitted on the boxhead that they come in contact with the guide rail and lift the bucket's weight off the travelling rope. The carrier is then manhandled along the rail for loading or unloading, thence to the rail and where it is picked up by the moving rope.

BOARD OF FORESTRY, DEHRA DUN, JULY 1925.



Standing (left to right). – Messrs. A. R. Dicks, C. F., Bihar and Orissa, H. W. A. Watson, C. C. F., Burma, A. G. Edie, C. C. F., Bombay, F. F. R. Channer, C. C. F., United Provinces, W. Mayes, C. C. F., Punjab, E. O. Shebbeare, C. F., Bengal.

Seated. – Mr. A. Rodger, President, F. R. I. & C., Sir H. A. Farrington, C. C. F., Central Provinces, Sir Peter Clutterbuck, I. G. F., Mr. H. Tireman, C. C. F., Madras

In this installation the forests are situated on the upper parts of Patriata ridge, the top of which is some 7,200 feet a. s. l. The destination of the produce is Murree, from which Patriata is separated by two deep valleys, the lowest points being 1,500 feet below both. The length of the ropeway is 3 miles; the Patriata loading station is 933 feet above the intermediate station at Galehragali, where produce from the lower forests is loaded. From this point the hill rises at a surface gradient of 1 in 3 to the unloading station at Charehan, 1,113 feet above the lowest point of the route.

Owing to the configuration of the ground the line of the ropeway changes by 7° horizontally, and this is provided for at Galehragali by an angle station fitted with a large guide wheel on a sloping axis. The cable passes round a horizontal wheel at Charehan, where the driving power is provided by a Robey Portable Steam engine. The cable is supported at intervals on trestles, the tallest of which is 100 feet high. On these the cable runs on a bank of four trolley wheels borne on a "trestle sheaf" which takes up the vibration.

At the Patriata end the terminal wheel is not horizontal but is mounted on a movable truck which acts on an inclined length of trolley track. This truck is maintained in position by a length of tension cable to which weights of 1·8 tons are slung pendulum-fashion in a pit. Plate 30 shows the tension truck in position with the 9-foot terminal wheel in motion.

The rope moves at 4 miles per hour and delivers 4 tons of wood per hour. The bucket carriers are 5′ × 2′, box-shaped with open ends, and 32 are kept at work. Alternate buckets are loaded at Patriata and the alternate empty ones are loaded at Galehragali. The engine in its present condition will not pull the ropeway if all loading is done at this bottom intermediate station and the whole load has to be pulled uphill. Loading alternate buckets, or sending all the load from the highest point makes gravity do part of the engine's work. A ringing magneto telephone is fitted at each of the three stations, the wire being fixed to the trestles, but in such a position that it will not come in contact with the moving buckets.

History.—The Ropeway was erected in 1910 for the supply of firewood to the Murree Cantonments. The installation was sent out from England by Ropeway's Ltd. and its erection was supervised by their expert. The greater part of the engineering work was done by local labour under his supervision, while the masonry foundations of the trestles were built by the P. W. D. The original type of carrier with a single boxhead proved to be quite unsuitable and fell off frequently. It was only after Mr. Underhill, Ropeway's expert, had designed a bucket carrier slung on two boxheads, that the ropeway functioned properly in June 1911.

Since then it has been in regular work, and gave very little trouble until 1920 when the original wire-rope showed signs of wear. A new rope was fitted by Messrs. Gillanders, Arbuthnot Co. in 1922 and the boiler tubes were replaced in the same year. The new rope after three years' steady work is in very good condition, but the engine, now 15 years old, is hardly up to the work that is expected of it. As originally fitted this engine was classed as 22 H. P. but in a Boiler Inspector's test in 1923 it proved to be only 15 Brake H. P. As it is hoped to obtain funds for an extension of the Ropeway for a further 1¾ miles towards Murree in 1926-27 a new engine will be provided at the new terminus, capable of working the increased length of line and also the sawmill which is at present worked by a separate oil engine.

In 1913 and again in 1922 the installation was overhauled by ropeway experts. Apart from the cable and the engine, the only parts which have been replaced are the trestle-sheaves, 120 of which were renewed in 1923. An indication of the efficiency of the outfit is shown by the fact that in June 1923, by working 8 hours daily, no less than 22,000 maunds of firewood were carried over the ropeway, which is now running as well as ever before. This is fortunate, because the demands of the S. and T. for firewood have increased greatly in the last three years, and it is likely that the ropeway will have to carry a sustained annual yield of 80 to 100 thousand maunds, as against the 40,000 originally estimated.

Since the discouraging experiences of the first few months running when the unsuitable single-arm buckets gave so much trouble, the only serious accident was in 1922, when the newly replaced tension trolley cable broke away from its clamps on the suspended 1·8 ton weight. The tension trolley bearing the 9 foot wheel on which the travelling cable is reversed was thus released like a catapult and was dashed against the masonry of the Patriata loading station, doing considerable damage, while several buckets were knocked off the line by the shock.

Financial Results.—Capital and Profit and Loss accounts have been compiled annually on the lines laid down by the Accountant-General, Punjab, and are filed in the office of the Western Circle Forest Office in Lahore. In these profits are shown on the basis of "ropeway fees" which have been arbitrarily fixed from time to time according to the approximate costs of working. This has formed a book credit which has been theoretically deducted from the revenue yielded by S. and T. payments for firewood, or debited to the department for other items such as timber, water, grain and other stores including touring officers' kit and office.

In the attached schedule, however, I have not shown these "ropeway fees" but have worked out the actual cost per maund from the total maundage carried against the actual expenses plus overhead charges for depreciation and interest on capital expenditure. The capital cost of the ropeway has amounted to Rs. 96,528, of which Rs. 62,969 was the cost of the original installation, and the balance was incurred in 1921 and 1922 in replacing the wire rope, refitting the engine with new boiler tubes, and surveying proposed extensions. A sum of Rs. 2,781 per annum has been set aside for depreciation, while the interest on capital expenditure has been charged at 3½ per cent. up to 1917 and at 6 per cent. from 1917-18 onwards.

In order to show the practical value of the ropeway, I have compared the actual running costs plus overhead charges with the corresponding charge for pack transport which we should have had to meet had the ropeway been absent. As a matter of fact we could not possibly handle the present annual outturn with

pack transport, as there are not sufficient bullocks or other pack animals in the district. Apart from the carriage of sawn timber, a certain amount of which is carried each year, the S. and T. demand has increased from 30 to 40 thousand maunds in pre-war years to 80 thousand or more per annum since 1922. No system of pack transport could cope with such a quantity.

Carriage rates for local pack transport rose from about 9 pies per maund mile in 1910 to about 1 anna 9 pies in 1922 and have since fallen again to the present rate of 1 anna 3 pies. For the route traversed by the ropeway the rate has risen from 4 annas per maund to the present rate of 9 annas while the average cost per maund on the ropeway over 15 years' running, works out at 2 annas 4 pies per maund. A comparison of the total actual expenditure on the Ropeway, including all overhead charges, and the corresponding figure for pack transport, shows that the ropeway has saved us over 2½ lakhs of rupees, and as long as the present S. and T. demand continues, the saving is about ½ a lakh a year. A further point to remember is the added expenditure on upkeep of forest roads, had this enormous total of 28,000 tons been carried by pack, a figure which I have not attempted to estimate.

General Remarks.—Experience has shown that the system of endless monocable ropeway is easy to operate, but probably a system of fixed carrying ropes and an endless travelling control rope would be preferable in future installations, because the latter system enables steeper gradients to be traversed and heavier loads to be carried.

Care must be taken in erecting a ropeway, not to budget for a larger outturn than can be confidently anticipated; the large charges on account of depreciation and interest on a needlessly expensive plant would ruin the project economically. This is very clearly shown in the attached schedule by comparing the years 1912-13 and 1923-24. In the former year a total carriage of 18,065 maunds worked out at 5·12 annas per maund, while in the latter year, six times that amount was carried at a cost of only 1·77 annas per maund, although in the interval the overhead charges had increased by about 30 per cent.

Special care must be taken to fix the terminal depôts in situations where there is ample space for stacking room and for the erection of subsidiary plants such as sawmills, etc. It is also advisable to provide one engine of sufficient brake horse power to work any such extra plant in addition to the haulage of the ropeway.

In all situations where our own wood obtains a good price and where the carriage costs on oil fuel are not excessive, it is advisable to have an oil engine in preference to a steam engine, for sooner or later the boiler tubes of the steam engine give trouble which requires an expert mechanic to cure, while the oil-driven engines are longer lived and in other ways more economical.

When a new cable is fitted, it stretches so much during the first few weeks' work that the tension weights reach the bottom of their pit. When this happens the cable has to be shortened by taking a length out of it and resplicing the ends. For splicing work a very heavy block and tackle equipment is required to secure the loose ends and take the weight of the entire length o suspended cable. Finally, a line of country should, if possible, be selected which allows a direct line of cable without the erection of " angle stations " which are necessary for any divergences from the horizontal path. A list of the personnel employed is given below. The men permanently employed on the ropeway are given a " ropeway allowance, " as it is recognised that the work is harder and less congenial than the usual forest work.

For engine and unloading depôt :—

1 Mechanic @ Rs. 110 per mensem.

1 Darogha @ " 27 " "

1 Forest guard for telephone maintenance @ Rs. 16.

1 Greaser @ Rs. 18.

1 Chowkidar @ Rs. 13.

3 Permanent coolies @ Rs. 15 p.m. each.

For the two loading stations :—

2 Foresters @ Rs. 35 and Rs. 25 p.m.

2 Forest guards @ Rs. 20 and Rs. 16 p.m.

2 Chowkidars @ Rs. 13 each p.m.

About 6 coolies on 10 annas daily wages.

R. MACLAGAN GORRIE, B.Sc., I.F.S.

EXPENSES OF PATRIATA ROPEWAY.

Year.	Expenditure.		Including overhead charges.	Cost in annas per md.	Cost in packs per md.	Pack transport on annual total carried.
	Gross weight carried	Ordinary.				
	Mds.	Rs.				Rs.
1910-11	75,344	3,017	3,976	0·84	4	14,880
1911-12	50,276	2,530	7,263	2·31	4	5,625
1912-13	18,065	1,008	5,786	5·12	4·25	minus 982
1913-14	41,352	2,144	6,837	2·59	4·50	3,625
1914-15	38,977	1,915	6,510	2·67	5	5,676
1915-16	31,900	1,590	6,088	3·05	6	5,881
1916-17	38,802	1,184	5,585	2·30	6·50	9,361
1917-18	50,171	1,546	6,937	2·21	7·50	16,591
1918-19	33,769	1,445	6,669	3·16	8	10,215
1919-20	25,964	865	5,922	3·65	9	8,711
1920-21	33,788	1,863	5,531	2·62	9·50	17,687
1921-22	34,599	4,147	8,944	4·14	10·50	13,569
1922-23	87,257	7,650	13,286	2·43	9·50	38,557
1923-24	118,662	6,696	13,141	1·77	9	53,620
1924-25	105,791	5,739	11,895	1·8[illegible]	9	47,606
Totals ..	7,84,717	114,370				Rs. 2,50,622

Average cost per maund on ropeway *2·33 annas.*

TIMBER EXTRACTION IN THE BERNARDMYO FORESTS, UPPER BURMA.

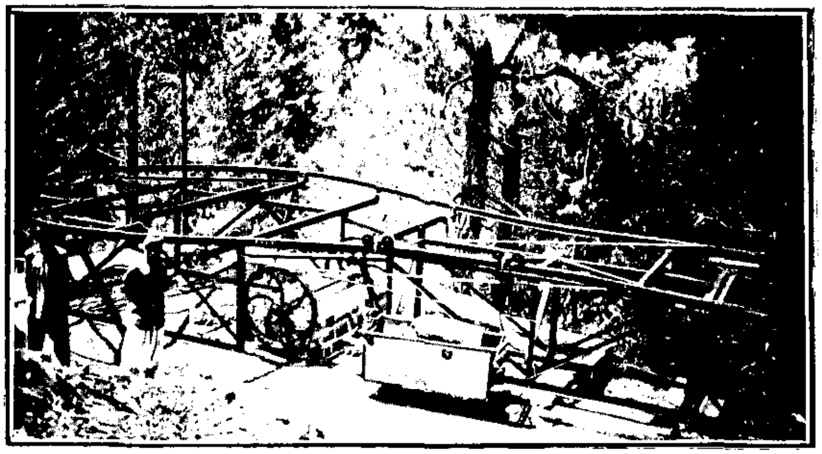
The following quaint methods of conversion and transport of timber may interest readers of the *Indian Forester*. It is seldom that mules are employed in the transport of heavy timber, but in the Bernardmyo Reserve of the Mogôk Forest Division, this is the case. The method of converting the timber here, is also unusual.

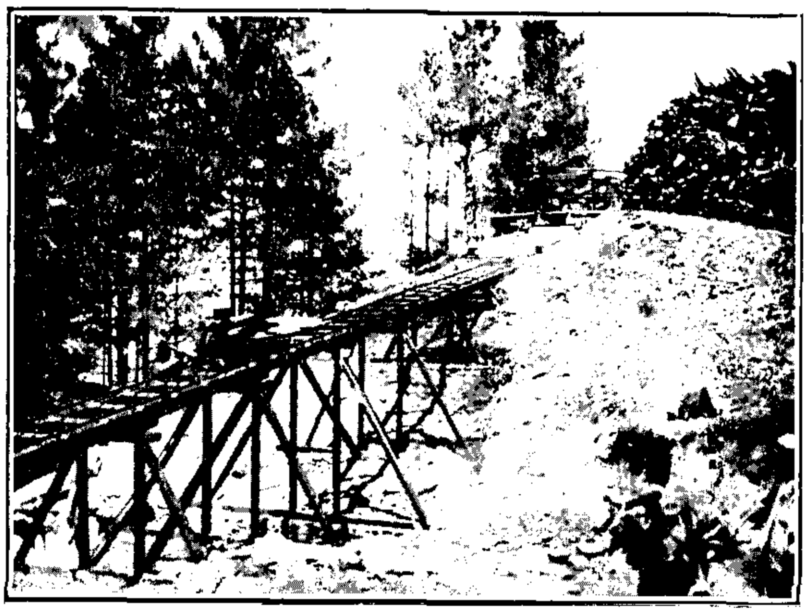
The forests from which timber is obtained, are evergreen in character, and occupy steep mountain slopes, at an elevation of about 6,000 feet. Movement of the logs is naturally a difficult matter, so the timber is converted at the felling site before it is transported the eight or ten miles to Mogôk, where it supplies a purely local demand.

The most important species extracted are *Yedama (Cedrela* sp.) and *Hlega (Machilus villosa)*. The latter is known locally as Mogôk teak.

The labour employed is of two kinds, namely, Chinese and a class of people known as Maingthas or Chinese Shans. These men are very hard-working, and in the case of the Chinese labour the work of conversion is carried on from day-break up to as late as even 9 or 10 o'clock at night.

Felling and conversion of the timber is done by hand, and in the method adopted no sawpits are made. Logs are first roughly squared as they lie on the ground by means of axes, and this is usually done by two men, one on each side of a log. The log is then raised at one end, and after the positions of the necessary longitudinal saw cuts are marked, the timber is sawn into its several pieces to about half its length only. The raised end is then lowered to the ground again, the other end of the log raised and sawing is recommenced. The operation is completed by the second set of saw-cuts meeting those originally made from the opposite end of the log.





Figs. 1 *and* 2. The Patriata Ropeway, Punjab.

(Illustrating article on p. 537.)

Fig. 3. Timber Transport in Mogok Division, Burma.

(Illustrating article on p. 544.)

The sizes of timber which meet the requirements of the market, are as follows :—

6″ × 6″ Lengths of 18′, 12′, 9′ and 6′.
12″ × 2″ „ „ 18′, 12′, 9′ and 6′,
18″ × 2″ „ „ 7′ 6″.

The carriage of the converted timber to the market is effected by various methods including transport by man-power. In the latter case even pieces of the largest size mentioned above are transported by the Maingtha coolies. The usual mode of transport, however, is by mules. This is undertaken by Chinese muleteers, who, it seems, are accustomed to use this method in their own country, and their animals are well trained to the task. In addition, the men are expert in the art of loading the timber in the way illustrated in the accompanying photograph (see plate 30, fig. 3). It is evident that very careful balancing of the loads is necessary. One, two or, occasionally, three pieces of timber, according to size, are loaded on each mule.

When bringing down the timber to the main paths the mules have to descend steep zigzag tracks, which are roughly formed simply by the clearing away of the undergrowth, and the subsequent constant trampling of the ground underfoot. A string of mules making its way down such a track with the animals struggling and striving to maintain the balance of their unstable loads which, to their apparent discomfort, toss and sway about their ears presents a grotesque spectacle, to which the astounding series of noises emitted by the Chinese muleteers, ranging from a hiss through the teeth or a resounding click of the tongue, to a shrill falsetto shriek, adds a distinctly ludicrous element.

L. NESTOR, B.F.S.

SOME IMPRESSIONS OF FORESTRY IN EUROPE.

At the present stage of the development of the Indian forests, it would be interesting to describe briefly some of the impressions of European forestry, which were formed during a tour on the Continent in July to September 1924. What strikes

2

one as the most interesting feature of the forest management on the Continent is the bewildering number of systems which have been evolved to suit the local conditions; indeed there are as many systems as there are forests and it is difficult to find two forests managed on precisely similar lines.

The well-known "Uniform Method" which was developed in France has undergone so many modifications that there are few forests where it is literally adhered to. The only classical example which approaches to some extent the text-book description of the Uniform Method is the beech forest at Lyon (Lyons La Forêt) which has been divided into six self-contained blocks according to the orthodox method. The natural regeneration is obtained in the oldest block by slowly opening up the canopy in order to let sufficient light for the development of the young seedlings and yet to protect them from frost by not creating large gaps; beech being very frost tender. To achieve this, a series of thinning operations is carried out, the frequency of which depends on the susceptibility of beech to frost; its demand for light and occurrence of seed years. Very often, therefore, considerable divergence exists between the actual practice and the conventional technique, which consists of preparatory, secondary and final fellings. Unlike his German contemporary, the French forester, as a rule, shows remarkable patience in waiting for natural regeneration and not unfrequently he would rather exceed the given period in which a block is to be regenerated than to take recourse to artificial means.

Amongst other forests where this method is adhered to, the forest of Tronçais in France affords a good example of how economic considerations influence the management of forests. A deviation from the usual Uniform Method has been deemed expedient here in order to insure a sustained supply of large sized oak timber to keep the barrel industry going and this is effected by deliberately delaying the final fellings.

A variety of modifications of the Uniform Method has been evolved on the Continent to meet the special requirements of different species and to suit local conditions. The classical

method, insisting as it does upon self-contained blocks, involves considerable sacrifice in maintaining rigid blocks, which forms the main obstacle to its universal adoption. Several modifications *have been made to overcome this difficulty, the chief* among them being the floating block, the block unique and the *quartier bleu methode* which roughly consist in demarcating the oldest block for regeneration and vary from one another in minor details.

The technique of opening the canopy for inducing natural regeneration has given rise to a number of variations which pass under the names of the Group, the Wedge and the Strip methods. The Group method consists in making large gaps in the canopy to obtain natural regeneration and is applicable to frost hardy species and to localities which are free from the damage of winds. The Wedge method as practised in Baden (Germany) has been devised to protect the young crop from the prevailing winds and to reduce the damage done to young seedlings in course of extraction of timber to a minimum. Triangular strips are cut with the apex of the triangle against the wind in the block selected for regeneration. The young seedlings obtained in wedges are protected from the prevailing winds which spread in wedges that act like funnels. Several picturesque modifications of the Wedge method are in force in Baden, varying from each other only in minute details. An interesting modification was perfected by Wagner who made a careful study of various factors, like frost, rain, wind and sunlight with respect to the point of compass, which influence the natural regeneration and ultimately struck upon the aspect where optimum conditions prevail. Karl Philip has, on the other hand, developed a cutting key which looks as pretty on paper as it is difficult to adopt in actual practice. To appreciate these interesting attempts at obtaining natural regeneration it is necessary to remember that climatic conditions which prevail in Germany are such that the Uniform method which has been so successful in the mild climate of France, fails to give satisfactory results.

The Strip method is a sort of half way house between the Uniform method and the Clear felling system. Instead of carrying out a series of thinnings to induce regeneration a strip is

clear felled and seed bearers are left in bands instead of being dotted about everywhere in the regeneration area. These trees serve both as seed bearers and as protection against winds, while the damage done to the young crop by their removal is reduced to nothing.

The maritime pine forests of Gascony (France) illustrate the achievements of the French forester in reclaiming vast areas from the encroachment of sands along the south-west coast of France. These plantations started about the middle of the nineteenth century reclaimed about 125 square miles and are to-day a source of considerable revenue to the French people, and what was once a swampy unhealthy and barren tract of land now forms a play-ground and place of health resorts, for holiday makers. The forester succeeded where the engineer failed and ever since afforestation has been recognised as the best and the cheapest method of land reclamation and protection of hill sides, for the works of engineering not only involve an almost prohibitive initial outlay of capital but also recurrent charges for repairs and upkeep. Even then, the land so reclaimed is not rendered as fertile and pleasant as it is under forests.

The maritime pine thrives well on loose sandy soil and shows a marked preference for tracts in the vicinity of the sea. The forests of this pine created from plantation are worked under clear fellings. On account of the profuse seeding which occurs every year and the great light demanding nature of the seedling, there is no difficulty in obtaining natural regeneration, which follows as a matter of course, as the result of the clear felling from the seed lying on the ground or seed shed from the trees felled on the area. In the year after the fellings, the whole area is found covered with a dense growth of seedlings, which grow so fast that thinnings have to be started as early as in the third year of their life and are repeated at intervals of 3 to 5 years. Before the clear felling takes place, all undergrowth and advance growth are cut down and cleared from the coupe, so that the new crop grows uniformly all over the area.

The superiority of a system from the point of view of silviculture can only be judged by the extent to which it profits

by the action of nature or helps it in regenerating the forests. Nature is not fond of rigid systems and it is not possible to force its pace. To the extent that a system attempts to rule nature and all systems are more or less like that, it goes beyond its proper limits and is met with a corresponding measure of failure. It is this that explains the failure of regeneration in a varying degree under every system rigorously applied. The wholesale application of any of the European systems to India without due regard to the climatic and economic factors is likely to end in disastrous results. Attempts to introduce the intensive German methods of geometrical fellings or the French method of self-contained compact periodic blocks, in this country have little chance of success. Nature's method is not a single system rigidly applied but a combination of them judiciously practised. The lesson is to profit by the regeneration already on the ground and while extending it, to go over the area with regeneration fellings in whatever form, strips, groups or otherwise, according to the silvicultural requirements as quickly as possible. Such a judicious combination following the guidance of nature is what should be done in the forests of India.

M. P. BHOLA, I.F.S.,

and

ISHWAR DAS, *Punjab Forest Service.*

THE EXPORT OF SUNGRASS FROM UNCLASSED STATE FORESTS OF CHITTAGONG HILL TRACTS DIVISION.

History.—In the Chittagong Hill Tracts, Bengal, there are 476 Sungrass ***khollas***, the number of which is gradually decreasing. All those ***khollas*** lie in the Unclassed State Forests and are leased by the Deputy Commissioner for a term of 1 to 7 years. From the year 1903 to 1916 the revenue realised by leasing the ***khollas*** has decreased from Rs. 9,642 to Rs. 6,558. When the sungrass is exported from Chittagong the river dues are realised by the Forest Officers in the Toll Stations at Rs. 3 per thousand bundles of 1′ 6″ girth. At present the Chittagong Hill Tracts

District is divided into three Forest Divisions. Only the Karnafuli river with its tributaries, Chengi, Subalong, Ringkheong and Kassalong are within the jurisdiction of the present Chittagong Hill Tracts Forest Division and the revenue on all the sungrass exported from the above rivers is collected at Fringkheong Toll Station.

In the Chittagong Hill Tracts Division, the Kassalong valley has the biggest and most extensive sungrass *khollas*; there are 17 big *khollas* in that valley.

Present system of sungrass export.—The Sungrass *khollas* in the Unclassed Forests are sold by the Deputy Commissioner by auction and the lease-holders again sub-lease the same to the cutters, who cut the sungrass and export it on bamboo rafts and pay the river dues to the Forest Toll Station. The Kassalong valley was leased to one Indrajoy Dewan of Kassalong Mukh for Rs. 360 a year. Every year during rains he sub-leases all the *khollas* to the Chittagonian traders. The sub-lease-holders engage sungrass cutters for a term of two months and send them to the Kassalong valley to cut sungrass. These cutters on their arrival at Kassalong Mukh pay 8 annas to the lease-holder as entry fees, and register their names in his office. They commence the cutting of the sungrass about the middle of December every year. The sungrass is cut and stacked on the riverside.

Mode of export.—The sungrass from the Kassalong valley is exported on bamboo rafts. The Government have leased all the bamboos in the Kassalong Reserve to India Paper Pulp and Co. except *daloo* which is specially kept for the purpose of sungrass rafting from the Kassalong valley. These *daloo* bamboos are cut by the local cutters and sold to the sungrass cutters at Mainimukh. The sungrass sub-lease-holders are mostly poor men, who borrow money for payment to the cutters, so that they cannot buy the *daloo* bamboos at their own cost and depend mostly on the middlemen.

These middlemen (bamboo traders) have combined together and formed a league. They purchase all the bamboos at Mainimukh from the bamboo cutters daily, and hold an auction every night in which one of them buys the whole lot purchased that day at a higher price. The profit thus obtained is divided among

them daily according to some fixed share. The men who purcase the bamboos sell them to the sungrass cutters at a high rate; thus the *daloo* bamboos are sold to the sungrass cutters at double profit, which is really a kind of monopoly. As the sub-lease-holders get cutters for a term of two months, they must supply bamboos within that period; otherwise the sungrass cutters will go away leaving the sungrass on the river bank. As they cannot pay the price of *daloo* bamboos in cash to the cutters, so they are compelled to buy them at a high price from the bamboo traders. The sungrass rafts take about two months to travel from the Kassalong valley to Chittagong, so the bamboos remain immersed in water for that period and deteriorate, hence the price is reduced greatly at Chittagong.

The price of *daloo* bamboos varies from Rs. 80 to Rs. 140 per thousand at Mainimukh, but will be sold at Rs. 40 to 60 per thousand at Chittagong after the unloading of the sungrass. So the sungrass cutters will lose about Rs. 60 a thousand. This loss they will recover from the price of the sungrass. A thousand *daloo* bamboos can carry about 5,000 bundles of sungrass, so the price of the sungrass is raised to Rs. 12 a thousand for this loss.

Proposed system.—Mr. Ascoli in his report on the Chittagong Hill Tracts proposed that these sungrass *khollas* should be given to the Headmen of Mauzas and the tolls realised by the Forest Department should be doubled. The present Deputy Commissioner of the Chittagong Hill Tracts, who always takes much interest in the Forest Department, is now trying an experiment on the subject on the southern part of the District, and if he extends the same to the northern part of the District, especially in the Kassalong valley it will give an increased revenue to the Forest Department.

The present sub-lease-holder in the Kassalong valley is now levying many unnecessary taxes on the sungrass cutters; such as: presents, labour and fees on the bamboos used in rafting sungrass. He is charging Rs. 5 per thousand for bamboos used for rafting sungrass. If the Deputy Commissioner extends the new system to the Kassalong valley, these additional charges will disappear. I have consulted many sungrass traders and all are

willing to pay double toll provided the sungrass *khollas* are placed in the charge of the Headmen and proper steps are taken for their protection.

Cause of deterioration of sungrass khollas.—At present the Chakmas are keeping buffaloes in many villages adjacent to sungrass *khollas*. They are grazing in the sungrass *khollas* and damaging the sungrass and thereby many valuable sungrass *khollas* are deteriorating. If the sungrass *khollas* are given to the Headmen they will probably not take special care to prevent buffalo grazing, so steps should be taken to stop this. I propose that a Police Patrol consisting of 2 head constables and 4 armed constables may be maintained to patrol the sungrass *khollas* in the Unclassed State Forests, when they have been handed over to the Headmen of respective Mauzas. The cost may be paid by the Forest Department out of the increased revenue. This will do more good, because the Chakmas always trouble the sungrass cutters and demand money, and if this is not paid, they set fire to and burn the sungrass on the bank of the river. This year about 2,00,000 bundles of sungrass were burnt on the bank of the river. If the new system is enforced we shall get about Rs. 12,500 more a year to start with and the above staff will cost about Rs. 2,500 a year. So the net gain will be about Rs. 10,000 a year. Besides the above, if a Police patrol is posted, the facilities for the Chittagonian cutters will get better and more men will come to cut sungrass, hence there will be more export and more revenue.

This year about 800 men went to Kassalong valley to cut sungrass and in my opinion if 3,000 to 4,000 people are engaged the whole of the sungrass cannot be cut. It is desireable to maintain these sungrass *khollas* which will be a source of constant revenue in future.

The following statement will show the revenue for sungrass, realised at Fringkheong Toll Station :—

1921-22	...	Rs. 9,793	1923-24	...	Rs.	13,423
1922-23	...	,, 10,072	1924-25	...	,,	9,949

M. C. CHAUDHURI,

Divisional Forest Officer, Chittagong Hill Tracts.

SOME NOTES ON LAC CULTIVATION.

(*Continued from* "Indian Forester," *Vol. LI, pp. 483—498.*)

EXISTING SYSTEMS OF CULTIVATION.

Lindsay and Harlow as well as Misra condemn certain methods of cultivation which are commonly practised. Although it is true that there are certain methods which are open to improvement it will be found that in most cases the local system of cultivation has been evolved to meet the exigencies of the host and other local factors.

(*a*) FACTORS GOVERNING METHODS OF CULTIVATION.—The principal factors which govern local methods of cultivation are as follows :—

(1) *Season of shoot production.*—Local experience indicates that the best shoots are produced when the host is pruned while in a state of greatest vegetative inactivity. This period is about February for ***kusum***, March-April for ***palas***, and April-May for ***ber***. In "Forest Research in India, 1923-24" the Central Provinces report that they have found that in Raipur there is no difference between shoots produced on ***kusum*** pruned in the months of August-September and January-February respectively. This may be so but it is not so far confirmed by experience in this Province. Again Troup * recommends pruning ***palas*** trees in the months of July and October, but adduces no evidence in support of this recommendation. No significance was attached to the fact that much better shoots were produced in the course of the experiments on trees which were accidentally pruned in the month of April. At any rate, it may be assumed that nearly all trees only put out good shoots at one period of the year and that therefore it is possible to obtain only one complete crop in the season off each tree, and not even one full crop

* *Indian Forester*, XLV (1919).

per annum in the case of trees which are reserved for the production of brood lac in June or July. The optimum age of shoots fit for infection depends on the season in which trees were pruned, nature and vigour of host, etc. It is normally about 2—6 months for all species except *kusum* in whose case it is $1\frac{1}{2}$ to 4 years. In the case of certain species such as *palas* the shoots if the growth is vigorous become rather too corky for infection in October-November if pruned in March-April. In such cases rather later pruning is advisable.

(2) *Production of brood lac in summer.*—As has been mentioned above there are certain hosts, such as *kusum*, *Dalbergia latifolia*, *Ficus* species, etc., on which there is no difficulty in growing brood lac in the summer, but there are others such as *ber* and in some cases *palas* on which the production of summer brood presents rather a problem. There are two or three ways of surmounting this difficulty. Firstly, the cultivator can rely on purchasing his brood from localities where brood can be produced—a method which is obviously of limited scope. Secondly, he can grow his brood on species on which brood can be produced. This as will be show below is a common method. Thirdly, he can increase the percentage of trees on which he can grow brood if he infects them lightly. The very common practice which has been condemned by the above authors of harvesting most of the crop in April-May and leaving the rest to give brood is based on this fact. By collecting the majority of the crop in April or May the cultivator is not only collecting the lac in a condition which the shellac manufacturers prefer (see below), but he is relieving the tree of a great strain. The collection of part of the crop reduces the transpiring surface and the area of lac which the tree has to feed. Trees which cannot produce brood lac when fully infected can often do so

when the greater part of the crop is prematurely removed. Further the practice of leaving the brood lac on the upper branches of the tree is sound in that when trees such as *ber* are partially leafless it is the branches on the upper part of the tree which possess most leaves. There are of course arguments against this system, such as that poorer shoots are produced because the tree has not been completely pollarded and that much of the crop is cut immature but it must often remain as the only practicable system which the villager can adopt.

(3) *Theft.*—The risk of theft not only restricts the cultivation of lac by villagers to trees which can be protected from theft either by individual cultivators or by village communities, but it also affects the system of cultivation. The method of harvesting most of the crop in April or May minimises the risk from theft. Again where natural infection is carried out the risk from theft is less than under artifical infection and this consideration is also one which affects the system of cultivation.

(*b*) GENERAL SYSTEM OF CULTIVATION.—The system of cultivation on two or three of the principal hosts will be dealt with—

(1) *Kusum.*—The commonest method of cultivation is to prune the tree from one to two years before it is infected. Part of the lac crop is collected *phunki* and part *ari.* Natural infection is relied upon and once infected the tree is never free from lac. This system has little to commend it. Its advantage to the cultivator is that *kusum* trees are generally scattered and the crop is difficult to protect from theft; with natural infection there is less fear of theft. A further advantage is that it is commonly reported that a bumper crop of lac on *kusum* is only obtained

every few years. As the host is never free from lac under this system the cultivator runs no risk of missing the bumper years.

An improvement on this system is practised in Palamau district. *The tree is infected artificially in the first* season and the crop is then allowed to reproduce itself naturally for two or three seasons in succession. By the third season the tree yields a fairly full crop when the whole crop is collected and the tree given two years rest.

The best system of all is that practised in parts of Manbhum district. The tree is pruned one or two years before it is infected. An effort is then made to infect the tree as completely as possible. If the resulting crop is complete it is all harvested and the tree is then given about two or three years rest. Should the resulting crop not be complete a second *naturally infected* crop *is allowed* to grow.

(2) *Ber.*—The best method of cultivation on *ber* which I have seen is practised in Murshidabad district. The most intelligent cultivators employ a regular cropping rotation which involves the sub-division of their trees into four groups. In illustration of the functions of these groups the position in the month of April 1925 may be quoted. Group A was infected in October 1924 and the lac on it is being collected in April 1925. Group B was also infected in October 1924 but the crop is not collected until it matures in June-July 1925. Shoots carrying an imperfect crop are however removed in April. Group C was infected in June-July 1924 and the crop was collected in October 1924. Group D was infected in October 1923 and the crop was collected in June-July 1924. Groups C and D have only poor shoots in April 1925. In June-July 1925 Group D will be reinfected, and in October Groups A and C, one of which two groups will be cut in April 1926 and the other in June-July 1926

In actual practice the Groups do not remain constant for, say, in April 1925 the cultivator can reserve any trees in Groups A and B to give brood lac and in April 1925 any trees in Groups A and C. Further the cultivators do not adhere to the system rigidly. For instance, it was seen early in 1925 that the crop would be a very poor one as there had been unfavourable rain in December and January. If they had collected the crop off Group A in April 1925 Group B would not have yielded them sufficient brood lac. Consequently they left all lac bearing branches on all trees in both groups and pruned the rest. This procedure will enable them to have greater twig surface to infect in October 1924 than they would have if they had done no pruning.

In Chota Nagpur only a small percentage of *ber* trees can produce brood in June-July clear cropping with only artificial infection is rare. The principal systems of cultivation are the following. Firstly, there is the system of collecting most of the lac in April-May and leaving brood on only some trees on the upper part of the tree. The brood is allowed to swarm *in situ* in June-July and the resulting crop is used for infecting the trees artificially in October-November. This is a very common method where the *ber* trees can be relied upon to yield brood on the upper part of the tree. Secondly, there is the system of growing brood on other species, chiefly *palas*, and infecting the *ber* trees with *palas* brood in October. This is a very common method in Manbhum district wherever *palas* trees are found intermixed with *ber* trees. The *ber* trees are never infected in June-July as the *baisakhi* crop is the more important and so all *ber* trees are reserved for this crop.

Thirdly, we find that in some parts, such as almost the whole Pakur Sub-division in the Santal Parganas, no attempt is usually made to grow brood lac at all but it is all purchased from outside as *ber* is the only com-

mon lac host and few *ber* are capable of pro ducing brood in June-July. Fourthly there is a system which one cultivator in Purulia, Manbhum district, told me that he adopts and which sounds almost too good to be true. He informed me that he infected his *ber* trees with *palas* brood at the end of the month of September. The crop swarms in the middle of May and the brood produced is then put on *palas.* The resulting crop swarms in September and so on. If this information is correct, and I have not been able to check it, it means that this cultivator is using an earlier swarming variety of lac—a point of first rate importance for by its use and the employment of alternate hosts such as *palas* and *ber* the lac crop need never be on the host at its period of minimum vegetative activity. The crop matures on *ber* before the host becomes leafless and it is put on *palas* just after the host has come into leaf. Finally there is an excellent system which is adopted by the Chota Nagpur Lac Company in their *ber* plantation. They have taken a lease of some *kusum* trees. They grow their brood on these *kusum* trees and use this brood for infecting their *ber* trees in July each year. The resulting crop is used for infecting *kusum* trees. I believe that this system of infecting *ber* with *kusum* brood in July is practised to some extent in Singhbhum district.

(3) *Palas.*—As summer brood lac can be grown on this species much more easily than on *ber* clear cropping is commoner than on the latter species. All the same the system of collecting most of the crop in April-May and of leaving lac for brood purposes on a few branches of the tree (not necessarily the upper most as in the case of *ber*) is perhaps the commonest system. This latter system cannot probably be justified except in dry localities such as occur in parts of Palamau district.

(4) *Khair.*—This is not a common host but the system of lac cultivation on it in Palamau district is of some interest. The tree is either infected with *kusum* lac in July, or it is infected with *palas* lac in October. In the latter case the crop is cut in April.

(*c*) METHODS OF INFECTION.—The two methods of artificial infection practised are by single sticks and by bundles. In Murshidabad district infection is generally carried out by single sticks combined with infection by bundles wherever single sticks cannot be conveniently placed or where there is a risk of single sticks falling off the host. Great care is taken in selecting good brood lac and in a year such as 1925 where a local shortage of brood lac was anticipated many of the cultivators went off to other districts to hire *ber* trees and grow their own brood on them in preference to relying upon buying brood in the market. On a large *ber* tree as many as 600 single sticks are used in infection giving a lac crop of up to two maunds. Over most of Chota Nagpur infection is mostly done by bundles but the practice varies locally. Misra's method of basket infection has been tried by one or two cultivators but I was informed that the results were little if any superior to bundle infection and the extra expense entailed was not justified.

(*d*) INTERCHANGEABILITY OF BROOD.—I have already referred to the employment of *palas* brood for infecting *ber* trees. On the face of it this system would appear unsound as the yield from *palas* brood is inferior in quality to that from *ber* brood. Apart however from the fact that the cultivator has to use *palas* brood for lack of *ber* brood there is a scientific argument in favour of its use. Misra recommends that *ber* brood lac should be put on *ber*, *palas* brood on *palas*, *pipal* brood on *pipal*, etc., but at the same time he remarks that when brood lac on the same food plant and in the same locality is used for purposes of propagation for a number of years, it degenerates and requires to be changed. This problem has been further investigated by the Indian Institute of Science, Bangalore. Sreenivasaya* has shown

* Journal of the Indian Institute of Science, Volume 7, Part VII (1924). Contributions to the Scientific Study of the Lac Industry, Part IV. Comparative Chemistry of he Host plants of Lac, by M. Sreenivasaya.

that chemical factors greatly determine the fitness of a plant to bear lac. Nitrogen and reserve carbohydrates mainly contribute towards maintenance, the proteins towards growth, the alcohol soluble portion towards resin producing efficiency, and the mineral constituents, mainly phosphates, towards reproductive capacity The ideal host is one which harmoniously promotes these four activities. On some hosts, *e.g.*, *babul* and *ber*, the insect does not generate a virile brood ; on others, *e.g.*, *palas*, the insect can reproduce itself for six generations, and again on others; *e.g.*, *Acacia Farnesiana* and *Shorea Talura*, the insect can reproduce itself indefinitely. He also states that the resin producing efficiency varies with the species of brood, *e.g.*, *Ficus* species brood on *Pithecolobium Saman* gave a yield four times that of *Shorea Talura* brood on the same species. These investigations indicate that interchangeability of brood between certain species of host plants is scientifically sound, *e.g.*, if *ber* brood is maintained on *ber* for several generations it will suffer in virility and therefore the occasional use of a more virile brood such as *palas* brood is justified. Further research may indicate that the system of employing alternate hosts will give the best results.

While the whole subject of the possibilities of interchanging brood is at present obscure two or three facts seem to emerge. Firstly, with the possible exception of *kusum* there is probably hardly any pure strain of brood in the province. Most *ber* have at some time or other been infected with *palas* or *kusum* brood and *kusum* brood and brood of other species has been used from time to time to infect *palas*. Secondly, a lac crop grown on one host from brood on another species of host is intermediate in characteristics, such as dates of swarming, quality, etc., between lac crops grown on the two species of hosts from brood grown on these two species of hosts respectively. Thirdly, it is stated by cultivators that brood does not lose its power of propagating itself on its original host if only one generation intervenes on another species of host, *e.g.*, brood grown on any species of host from *kusum* brood can be put back on *kusum* with no resulting degeneration. If this fact is true it is one of immense importance as it implies that a system of alternate hosts can be employed

with any two species one of which would by choice be a high grade host such as *kusum*. It may be added that as the lac insect has evolved under forest conditions and as most of its hosts are non-gregarious in habit it stands to reason that it would be more natural to expect that the insect could migrate from one species of host to another without degeneration. In fact the Bangalore experiments tend to show that with one or two rare exceptions no host can indefinitely maintain the same variety of brood without degeneration setting in. It may therefore be surmised that each distinct variety of the insect has its own group of principal host plants between which it can migrate without degeneration. There may of course be many host plants on which it cannot maintain itself for even one generation, but unless it is assumed that it can migrate from certain hosts to others without permanent degeneration it is difficult to see how in the case of non-gregarious hosts the race of insects could survive. Further research may indicate that in the case of gregarious hosts such as *ghont* and *palas* the virility of the brood can only be maintained through periodic parthenogenesis.

In departmental lac cultivation experiments a genealogical table is now being maintained so that the pedigrees of different broods can be traced and it is hoped that in time more light will be thrown on the problem.

(*e*) RELATIVE VALUE OF DIFFERENT LAC CROPS.—The relative value of the different crops depends on the following main factors, apart from that of climate which has already been dealt with :—

(1) *Season of collection.*—The principal market crops in this province are the *kusmi* and *baisakhi* crops, and this holds true of most parts of India. The exceptions to the rule are the *ghont* areas of the Damoh region and the *palas* areas of Bhandara, both in the Central Provinces, and, according to Mahdihassan, Sind. Neither Lindsay and Harlow nor Misra attempt to explain this preference for crops. Mahdihassan states that the proportion of males to females is greater in the case of monsoon fed brood and that

in consequence the *katki* crop should be bigger than the *baisakhi* crop. He expresses surprise that the reverse should be the case over certain parts of India but it seems to me that very plausible reasons can be advanced in explanation of this fact. Firstly, as has been mentioned above the *katki* crop is inferior in quality because, as I surmise, the relative humidity of the air is higher during the course of its development. (It is possible that the difference in quality may be due to differences in the nature of the sap of the host at different seasons but this has not yet been worked out and in the meantime humidity seems to afford a rational solution.) Secondly, as has also been explained above, brood lac is much scarcer in the summer owing to the difficulties of growing it then and for this reason the *katki* crop must be smaller than the *baisakhi* crop. Thirdly, the *katki* crop suffers much more from predatory enemies. Fourthly, the *baisakhi* crop admits of the lac crop being grown on shoots of the optimum size. Fifthly, unfavourable climatic conditions are more likely to occur during the rainy season swarming period. The case of the *kusum* crops is different. Firstly, *kusum* brood swarms later than other brood with the results that the *kusmi* crop develops under drier conditions than the *jethwi* crop. Secondly, there is no difficulty in obtaining *kusum* brood in the summer; and thirdly, the factor of shoot production does not enter into consideration. According to Mahdihassan the ratio between males and females in the case of the *kusmi* and *jethwi* crops remains fairly constant, and it may therefore be inferred that the slight superiority of the *kusmi* crop is due principally to the fact it has developed under drier conditions. It is possible however that the relative value of the *jethwi* and *kusmi* crops varies according to local climatic conditions, *e.g.*, in Palamau the *jethwi* crop is reported to be the superior crop owing to cold and mist affecting the *kusmi* crop adversely.

The exceptions to the ordinary rules afforded by the *ghont* areas in the Central Provinces may be explained by the fact that under the usual system of cultivation there in force the trees are only lightly infected in October-November as they will not bear a full crop in June-July. If the Chota Nagpur system of initial heavy infection with partial harvesting of the immature crop in April-May to reduce the drain on the tree could be adopted the *baisakhi* crop would then become the principal one. As cultivation on *ghont* is carried out more in forest areas than in village lands the factors of labour supply and of facilities for carrying out the work become of greater importance and this is possibly one reason why the *katki* crop is of more importance. I do not know the relative quality of the two seasonal crops in Damoh, but Lindsay and Harlow state that there is reason to believe that the *baisakhi* crop is of better quality. The exception of the *palas* areas of Bhandara would also probably tend itself to explanation on local investigation being carried out. As regards Sind, climatic conditions are there different from all other main lac growing areas. The monsoon rainfall is low and probably most of the *babul* host trees are on irrigated lands. These factors would certainly affect the quality and quantity of brood produced in the two seasons, and might explain the greater importance of the *katki* crop.

One other factor which affects the value of the seasonal crops is the leaf habit of the host. Teak is a bad host for a *baisakhi* crop as so much of the crop is lost on the fall of the leaves. A certain amount of the *palas* crop is also lost on leaf fall but the loss is not sufficient to make the *katki* crop of more importance.

(2) *Time of collection.*—Both Lindsay and Harlow and Misra advocate that the lac crop should be preferably cut *phunki*. The latter in fact severely condemns the practice of cutting lac before it has swarmed and states

that manufacturers should combine and agree to purchase *phunki* lac only. So far as the *baisakhi* crop is concerned this recommendation is unsound. *Ari* lac gives a bigger outturn than *phunki* lac as it is less brittle and it is far less damaged by predatory insects. Consequently although of slightly poorer colour it fetches relatively higher price and is preferred by the manufacturer. Provided the cultivator does reserve sufficient brood lac to keep cultivation going it is unreasonable to expect him not to cut his crop *ari* when by doing so he will obtain an inferior crop and suffer more through theft.

(3) *Species of host and brood.*—Owing to the fact that except in the case of *kusum* crops the strains of brood lac used are rarely pure strains which have developed solely on particular species it is not possible at this stage to place the hosts in a definite order of merit based on the quality of lac they produce. The following is the approximate order of merit under local systems of cultivation :—

(I) *Dalbergia latifolia*, (II) *Kusum*, *Dalbergia lanceolaria*, *Croton oblongifolius* and *Ougeinia Dalbergioides*, (III) Khair, (IV) Ber, (V) Palas and (VI) Ficus species.

The information that *Dalbergia latifolia* produces the first quality of lac was only recently supplied me. I have checked it by enquiries from manufacturers and stick lac dealers in Ranchi and Manhhum districts who unanimously state that its lac is superior to that of *kusum*.

(To be continued.)

J. W. NICHOLSON, I.F.S.,

Provincial Research Officer, Bihar and Orissa.

THE DEODAR DEFOLIATOR.

(ECTROPIS SP. NOV., GEOMETRIDÆ.)

In 1922-23 the deodar forests of the Simla Hill States and Jaunsar were the scene of sporadic outbreaks of a geometrid defoliator, an undescribed species of *Ectropis*, which completely stripped large areas of more or less pure deodar, and is apparently causing the death of a high proportion of the younger poles and regeneration and to a less extent of the suppressed and dominated trees. The epidemic decreased as quickly as it had arisen and by 1924 had almost entirely died out.

As defoliation of this type is periodic the following note on the life-cycle of the pest and the history of the epidemic may be of use on the next recurrence.*

LIFE-CYCLE.--The colouring of the moth is dirty white speckled and lined with black; the male is normally winged and capable of flight (pl. 31, fig. 2), but the female has aborted wings and a heavy egg-laden body and is in consequence only able to crawl (fig. 3).

At Dehra Dun the moths emerged between the 2nd and 22nd February from hibernating pupæ obtained in Bawar Range, Chakrata, in the preceding month. The Range Officer, Kathian, bred out moths at 7,000 feet at the end of February 1924, and at 3,000 feet in early February. Material collected in July and October failed to live through the winter when transferred to Dehra Dun and no emergencies occurred, although dissection of pupæ 2—3 months old showed that the moths were fully developed.

In the field at Bodyar, Chakrata, moths on the wing and young caterpillars were observed in the first week of April.

The caterpillar is a looper, *i.e.*, with only two pairs of legs on the abdomen, is light green in colour (the green of the deodar needle) with greyish subdorsal and lateral lines; other colour

* It is a deplorable fact that the steady annual loss caused by insects too often passes without comment in the annals of the forest departments of India, and that catastrophic and spectacular outbreaks excite but temporary interest. The rare facts tha occasionally are preserved, as in the present case, may pardonably be given the dignity of print.

THE DEODAR DEFOLIATOR.

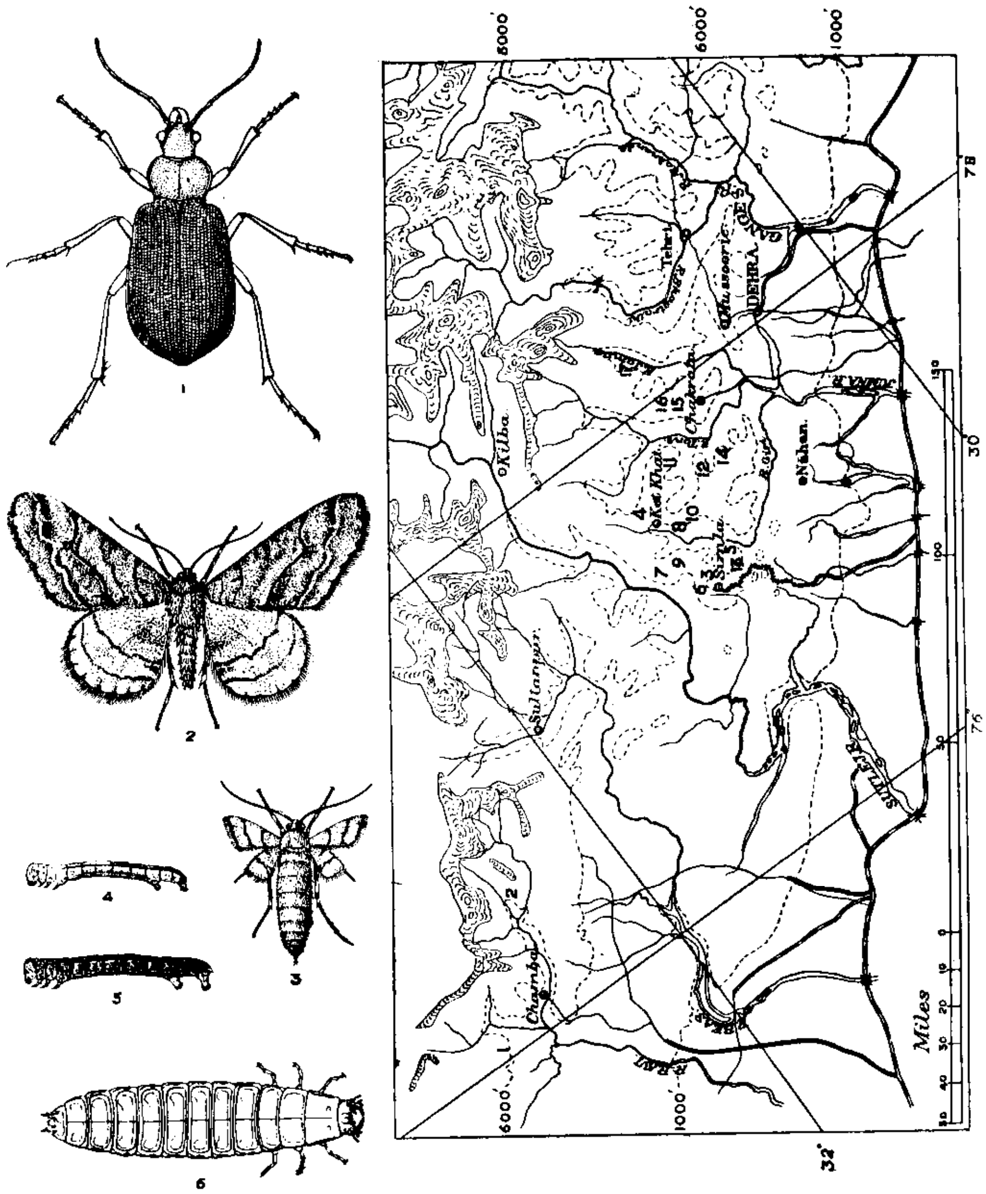


Fig. 1. *Calosoma beesoni* Andr.
,, 2. *Ectropis* sp. nov. (male).
,, 3. ,, ,, (female).
Figs. 4 & 5. ,, ,, larva showing two colour patterns.
Fig. 6. *Calosoma beesoni* Andr. (larva).

[All figures enlarged slightly.]

In the map the numbers indicate defoliated forests in the following localities :—

1. Guthan Reserve, Bhandal Range; 2. Bharmaur Range, Chamba State; 3. Simla Catchment Area; 4. Kalala, Kotkhai Range; 5. Keonthal State; 6. Koti State; 7. Nun, Bhajji State; 8. Ghund State; 9. Madhan State; 10. Balsan State; 11. Tharoch State; 12. Jubbal State; 13. Patiala State; 14. Sirmoor State; 15. Kanasar, Chakrata Division; 16. Kathian, Chakrata Division; 17. Banal, Tehri State.

forms are pale straw or pinkish brown above and in the later stages a mottled brown patterning appears which increases its resemblance to the smaller twigs and arrested shoots (figs. 4 and 5). When feeding the caterpillar eats the needle from the tip to the base or begins to gnaw near the middle. The half of a needle attacked in this manner falls to the ground or dries up and turns brown. The caterpillars spin readily and drop by means of silk threads when disturbed. In the latter stages of the attack the boles of the trees, branches and the undergrowth are covered with webs and veils of silk. The dead needles and excrement entangled in the silk and the withered clusters of needles produce the brown scorched appearance characteristic of a defoliated forest. In heavy attacks defoliation may be complete early in May. When full grown in June the caterpillars descend to the ground and crawl below the thick layer of needles covering the humus, where they pupate; no cocoon is formed. Throughout the rains and the winter the chestnut-brown pupæ remain in the humus until the rising temperature of spring brings out the moths. The life-cycle is thus annual.

HISTORY OF THE OUTBREAK, 1921—1925.

Early records.—Defoliation of deodar apparently by this species occurred in 1900-1901 in Kalela, and Theog forests, in 1906-1907 in Naldera forest, and in 1909 and 1911 also in Naldera; these localities are near Simla. No outbreaks during the following ten years have been recorded.

1921. It is presumed from the subsequent history that the insect had increased abundantly by the spring of 1921, but the only locality in which it was specially noticed and recorded was Deoki Kulhar forest, Sirmoor State. Here it is stated to have appeared in myriads at the end ot March and beginning of April and the trees were completely defoliated; rain occurred on the 13th and 14th May after which the pest disappeared.

1922. Numerous reports of the occurrence of defoliation were received in 1922, which appears to have been the year in which the general incidence of the pest was at its highest.

In the Simla Division defoliation took place in numerous localities totalling over 11,000 acres. According to information supplied by Messrs. A. D. Blascheck and W. E. Flewett the following forests were affected :—

Territory.	Forest.	Approximate area affected in acres.
1	2	3
Kotkhai Range	Kalala	800
Keonthal State	Chaneban, c. 28 ; Rathmun, c. 29—32 ; Kangar, c. 62 ; Kufta, c. 66 ; Cheog, c. 67—70 ; Plaina, c. 71 ; Majroha c. 72, 73.	1,149
Kothi State	Naldera ; Patgiar, c. 16 ; Kufri, c. 15.	10
Bhajji State	Nun, c. 12	20
Ghund State	Kalala, Bar	330
Madhan State	Kiari, c. 1 ; Naur, c 1	188
Balsan State	Lakhoti	120
Tharoch State	Arna, c. a, b : Chilla; Dhoandli; Loidhar ; Bijhol, Thanal. c. a, b ; Sarach ; Kangar, c , a, d. Khora, c. a, b ; Shashan, c. a, b ; Kandau.	8,944
	Total ...	11,561 acres.

Mr. Flewett noted that the attack was recognised about the second week in May and by the first week in June the forest had turned completely brown ; from the middle to the end of June the caterpillars descended to the ground for pupation. Mr. Blascheck stated that he had never observed such complete and extensive defoliation of deodar.

Patiala State.—In the forests of Patiala State near Simla outbreaks occurred in Jhabrot.

Sirmoor State.—In 1922 defoliation again occurred in Deoki Kulhar and appeared in the adjoining Haban Deothi and Mauva forest.

Chakrata Division.—Mr. F. K. Makins, D. F. O., reported defoliation of deodar in Kathian and in Kanasar particularly on suppressed and middle-sized poles. Mr. E. A. Smythies, Silviculturist, also recorded that "in mature trees or big poles only the lower branches have been attacked, but saplings and young poles up to a height of 60 feet have been completely defoliated in patches where there is a severe attack......Serious damage seems to be in Comp. 10, Kathian, though caterpillars are seen everywhere." In Kanasar compartments 16–25, Mr. Hira Singh recorded that "there was scarcely any tree which was not attacked," and that the heaviest damage occurred in compartment 25.

1923. The season of 1923 was characterised by the decrease in extent and severity of the attack in the previously infested localities and by the appearance of new outbreaks elsewhere.

Chamba State.—Defoliation was noticed in June 1923 in the Upper Ravi forest in Guthan Reserve, 140 acres of pure deodar, and complete stripping resulted.

Simla Division.—Mr. Flewett recorded that defoliation in the deodar forests of Simla Division was on the whole much milder than in the previous year. Near Simla the Catchment Area forests which were immune in 1922 were attacked. In Kotkhai Range, Kalala forest, no trees were completely defoliated and only comparatively dense parts of the crop were affected. In Keonthal State the attack in Cheog and Rathmun forests was lighter, as also in the forests of Ghund and Balsan States. The reports concerning the other states were vague.

Patiala State.—In 1923 the area heavily attacked increased, affecting the whole of Jhabrot and a portion of Chail.

Jubbal State.—Defoliation is stated by the Superintendent of Forests to have affected ten forests with an area of over 4,000 acres mainly in the Kanda valley.

Sirmoor State.—The areas previously defoliated were not seriously affected but new outbreaks occurred in Taprauli and Khabar forests at a distance of about 7 miles from Deoki Kulhar.

Chakrata Division.—In May 1923 defoliation was observed in Kathian, c. 10 and on a more extensive scale than previously.

It was ascertained that in 1922 complete defoliation had occurred in a small area in compartment 10, Kathian, but that in 1923 the whole of c. 10 and parts of 9 and 7 were affected. The area completely defoliated was about 500 acres. Mr. A. E. Osmaston observed serious defoliation near Bodyar.

Tehri Garhwal State.—Heavy defoliation was recorded in Banal forests "over an area ¾ mile in length."

1924. In 1924 the epidemic had almost entirely subsided in the original centres and was decreasing in the localities infested later.

Chamba State.—Messrs. H. K. Robinson and Blascheck noted that serious defoliation occurred in Guthan Reserve in April and the whole block turned brown.

From *Patiala* and *Jubbal States* no reports were received but presumably defoliation was not serious.

In *Sirmoor State* no defoliation was observed until the end of April.

In *Tehri Garhwal State* defoliation again occurred in last year's area but far less seriously; a new outbreak occurred in Purola Range.

Simla Division.—On receiving sanction to take up the investigation of the deodar defoliator the writer visited the Simla Hill States in May 1924, but by this date the epidemic had everywhere reached its climax and died out. No defoliation beyond that of a few survivors was found in the forests visited, *i.e.*, the Simla Catchment Area forests; Cheog, Keonthal State; Kaleri, Cheog State; Kalala; or between Jubbal and Tharoch; a mild attack was found over 10 acres in Kowa forest, Tharoch State.

In *Chakrata Division* (visited in June 1924) no defoliation was observed in the neighbourhood of Talrathach-Chachpur, in Lohasu Block, Kathian, Mandali, Konain, Kanasar or Bodyar.

1925. In 1925 the numbers of the deodar defoliator were everywhere so low that no defoliation occurred in a degree sufficient to cause comment with the sole exception of 7 acres in Kowa, Tharoch.

From the data recorded above it is evident that the occurrence of *Ectropis* sp. as a serious pest of deodar is limited to the forests in the outer ranges of the Himalayas between Chamba and Tehri-Garhwal (see map of the area, plate 31); it is unknown in the dry zone according to the testimony of the Divisional Officers, Kulu and Bashahr. The pest increases to abnormally high numbers in the course of one or two years, the epidemic lasts for two years, and as suddenly dies out. Serious defoliation rarely lasts in the same locality for more than two consecutive years.

Of the factors influencing these fluctuations in the incidence the most important appear to be spring rainfall and the natural enemies.

Rainfall.—The occurrence of heavy falls of rain or hail in March and April is sufficient to destroy the young larvæ and prevent noticeable defoliation. Meteorological data are wanting for localities within the epidemic area, but the general district records show that March and April were abnormally dry months in 1921—1923 and that very few of the daily falls exceeded half an inch of rain.

Natural Enemies.—The defoliator is subject to a most efficient control by its parasites and predators; an increase in the numbers of the pest is followed in the next season by a proportional increase in the numbers of its enemies, which by the third season are able to suppress it. Of the predators the most important by far is a carabid beetle, *Calosoma beesoni* Andr., which in the adult form (plate 31, fig. 1) eats the caterpillars, and as larva (plate 31, fig. 6) eats the pupæ in the humus. The chief hymenopterous parasite is a species of *Campoplegidea*. Tachinids are much less numerous. In a sample count made at Kathian in June 1923, the humus was found to contain 1,600 carabid larvæ, 760 hymenopterous cocoons and 80 tachinid puparia in association with 8,000 pupæ dead and alive of the defoliator. Of the latter only 30 per cent. were living and this residue was presumably destroyed by carabids during the course of the rains and autumn. A sample count made during defoliation at Kowa, Tharoch, in

May 1924, revealed beetles of *Calosoma beesoni* present at the rate of 3,000 per acre. Scarcely a trace of the natural enemies was to be found in localities where defoliation was not in progress nor had occurred.

Economic Importance of the Pest.—Complete stripping of a pure deodar forest is followed in July by a new flush of needles, which creates the impression that the damage is not serious. The injurious effect is, however, deferred; defoliation for two *successive years results in dying-off* on a scale that demands preventive measures. I am indebted to Lala Mul Chand Minhotra, Divisional Forest Officer, Simla, for enumerating sample plots totalling 40 acres in the defoliated localities of Kalala, Kufta, Cheog, Naldera, Patgiar and Kufri and the Catchment Area, Simla. In this region in *July 1924, the first year after the* epidemic, a mortality varying per plot from 8 to 30 per cent. of the crop was discovered. The dying-off was most numerous in the smaller girth-classes :—

Class.	I	II	III	IV	V
Percentage of trees dead.	4·2	6·2	7·2	16·2	41·8

(Average for all sample plots combined.)

Exceptionally severe losses occurred in Naldera forest comp. 19, a, b, where the mortality in the I to III classes combined was 42 per cent. of the I to III class trees or 20 trees per acre.

In Guthan Block, Chamba, the mortality had also reached a serious degree by July 1925, the first year after two years of heavy defoliation.

Observation in other localities in 1926 are obviously desirable.

Dying-off of deodar is due to a variety of unexplained causes, but in those cases due to defoliation the symptoms appear to be fairly constant. A defoliated tree usually dies from above downwards *and from the tips of the crown branches* to their bases. The bark of the bole dries in longitudinal patches which are fairly sharply limited from the living tissue; in the dying zone a discoloration and lattice-like shrinking of the

cambial surface takes place with the deposit of small white non-gummy globules, which later are blackened by the formation of a mould. The roots are the last portions to dry up. In such trees the insect fauna of the bark is absent or clearly secondary. Neither the bark-beetles *Scolytus major* Steb., *Polygraphus pini* Steb., and *Ips longifolia* Steb., nor the sapwood borers *Sphenoptera aterrima* Kerr., and *Tetropium oreinum* Gah. appear to be important factors in accelerating death.

Control measures.—The life-cycle of *Ectropis* and its natural control show that simple remedies can be devised for use when an epidemic recurs. On gently sloping clean ground, by raking and compacting the humus into heaps during the autumn, conditions can be created that are unfavourable to the emergence of the moths without hindering the development of the predators. On steep and rocky ground grease-banding the trees in early spring will prevent the female moths and newly hatched larvæ from ascending the trees.

C. F. C. BEESON,
Forest Entomologist.

METHODS OF SALE OF STANDING TREES.

In connection with Mr. Channer's interesting article in the September number of the *Indian Forester* on the systems hitherto employed in the sale of standing trees, it seems that attention in the past has been concentrated principally on *systems* of sale in endeavouring to overcome the various difficulties encountered in this important subject, and which are a constant source of trouble to D. F. Os. in running their divisions on both fair and profitable lines.

The *method* by which the trees are actually sold has also however, a considerable bearing on these matters, and one which appears to have been to some exent lost sight of in the efforts to overcome adverse circumstances by other means.

These *methods of sale* are limited, and those in general use are the ordinary auction system and that of sealed tenders,

Of these two the former is almost universally employed, as it is found that by the other method intending purchasers are inclined to offer a comparatively low figure in the off-chance of others having quoted even lower ones.

At first sight, therefore, it would seem that we are reduced to the one method of sales by the ordinary public auction with all its attendant weak points. The chief of these are :—

(*a*) The formation of "rings" to keep the prices down.

(*b*) The deliberate pushing up of prices to an unreasonable figure by men who do not intend to buy, but from pure spite wish to ruin some one whom they know intends to purchase the lot.

(*c*) The out-bidding of contractors of only moderate means by "big" men (who can easily put up with a temporary loss) in the hopes that the former will in future years drop out of the trade.

(*d*) The bidding of inexperienced men who are only capable of gauging the value of a lot from bids offered by others known to be contractors thoroughly understanding their job.

(*e*) The raising of bids to a figure far in excess of the true value of the lot by several competitors all wanting it badly and losing their heads.

In my present division—the Tarai and Bhabar—the conditions have always made it advisable to employ the lump-sum system, and the large numbers of contractors—usually between 200 and 300—that attend the auctions, and the very doubtful values of miscellaneous-tree lots which depend almost entirely upon local prices of *kokat* timber, has accentuated the difficulty of dealing with the above points in a public auction, and in my second year I sold the majority of lots to applicants as opportunity arose and at prices fixed according to my own estimate.

This worked comparatively well, but resulted this year in my being flooded with applications for lots, and I could not do otherwise than inform all contractors that I should revert to sales by auction.

However, determined not to leave things at that, I finally resolved to try as an experiment the system known as the "Dutch" auction. This consists in a reversal of the ordinary method, the auctioneer starting at a figure well above the value of the thing to be sold and gradually coming down until one is reached at which a purchaser indicates his willingness to buy. No further bid is considered, the sale thus being concluded by the first person to speak instead of the last as is the case in an ordinary auction.

Having therefore explained the new plan and giving a couple of dummy examples, the idea was quickly understood and favourably accepted by the contractors.

The results were even more successful than I had hoped, the outstanding features being—

(*a*) The sale price of no lot varied more than 10 per cent. from my own estimate of its value.

(*b*) No contractor got "worked up" and excited.

(*c*) Inexperienced contractors were unable to get lots as they had nothing upon which to base their estimates.

(*d*) No contractor could be pushed up or out by others from "Zid" or any other reason.

(*e*) The auctions were completed within four hours instead of taking the best part of two days.

The tendency was naturally for would-be purchasers to keep their eyes on others to see when they were about to speak, but the latter were usually able to avoid giving any such indication and always managed to get out their bids a fraction of a second before those watching them could follow suit.

Once only were two independent bids made exactly simultaneously no decision being possible, and the matter was settled by starting the sale of the lot over again.

Afterwards it was suggested to me that if this system were again employed next year the contractors would evolve some means of defeating it, but it is difficult to see how they might set about this. "Rings" can be made in the case of either form of auction, but whereas by the usual method a member of a ring will not dare to bid as he would immediately be opposed to the

utmost by the remainder, he might on the other hand, knowing that a single bid would close the deal, be tempted to seize an opportunity of getting a lot in which there is obviously money to be made. Furthermore, unless every single contractor has been roped into the combine they will not dare to let the price get very low for fear of an outsider, whom under ordinary circumstances they would be able to push out, snapping up the lot under their very noses.

As Mr. Channer points out, contractors are in much closer touch with conditions affecting the timber-market than the forest department can ever hope to be, and also the better of them pay little attention to a guarantee, relying much more on their own estimate formed in the light of previous experience, and being able to calculate more or less accurately the expenses entailed in working any given coupe.

For these reasons it may be expected that prices offered by the Dutch auction method of sale might do much in assisting to get good honest prices by the lump-sum system.

This method may possibly have been tried before, and may even be in general use in some provinces but I can find no record of its employment in the United Provinces of late years, and it would be interesting to know if there are reasons, other than those which have occurred to me, which make its adoption undesirable.

B. H. OSMASTON, I.F.S.

THE DIAGNOSIS OF DECAY IN TIMBER.

DIAGNOSIS OF DECAY IN WOOD, by EARNEST E. HUBERT, Assistant Pathologist, Office of Investigation in Forest Pathology, Bureau of Plant Industry, United States Department of Agriculture—Journal of Agricultural Research, Vol XXIX, No. 11, December 1924, pp. 523—567.

In the absence of the fructifications of fungi causing decay in wood, identification has always been a difficult problem to those interested in this line of investigation. The majority of specimens received for examination do not bear sporophores, and, merely from a histological examination of such specimens, the determination of the true causitive agent is impossible. Cultural methods to induce the internal organism to fructify are being tried, but the development of sporophores, particularly of Basidiomycetes, under ordinary laboratory conditions is not always a matter of certainty. In cases where the fruit bodies can be successfully grown by artificial means and identical decay produced by inoculation, the identification becomes an easy matter, but where these measures fail the worker has to face a great difficulty and is often handicapped.

The present paper, which is under review, attempts to put forward a procedure to overcome the above difficulty. It includes the results of the author's own investigations, which furnish a basis for a more accurate diagnosis of decay in wood occurring

in living trees as well as in timber. After giving passing references to previous works on other phases of wood-rot problems the author begins by saying that, when an unknown type of rot is intended for identification the first thing to do is to match it with authentically named specimens of rots which should be specially prepared for this purpose. Attention is drawn to the importance of selecting specimen from named collections when such comparisons are made; that is to say, if a specimen which is required to be identified has been collected from the sapwood of the root of a certain tree the authentic specimen should also be from a similar part of the tree, or if the former comes from the sapwood of the trunk, the latter must necessarily be from the same position. In the same way if the unnamed specimen has been secured from a living tree the named sample ought to be from a living tree also and so forth.

The next step is to study the gross characters which indicate the colour variations associated with the stages of decay, supported by a detailed microscopic examination of the hyphæ in the wood, their method of penetration, extension in and beyond the discoloured areas, shape and size of bore-holes caused in the cell-walls and the general pathological effect produced on the structure of wood. Cultural characters on artificial media, their comparison with authentic stock cultures, and the reproduction of identical decay in sterilised wood by inoculation from pure cultures, have been found of great value in completing the diagnosis of the casual organism in many cases.

The author then proceeds to define the process and the part played by enzymes in producing discolourations according to the decomposition of the various cell elements. On the basis of this chemical charge in colour a classification of rots has been suggested which forms the frame-work of the whole investigation. He divides the rots into two main groups (1) "White rot," (2) "Brown rot" with a further sub-division into white pocket rots, white ring rots, white mottled rots, and white spongy rots; brown pocket rots, brown ring and stringy rots, brown cubical rots, brown spongy rots and brown mottled rots. All characters enumerated in this paper have been presented in a systemic and

tabular form by means of which the relationship between certain types of rot and the causative fungi can be worked out. A representative number of fungi of economic importance have also been studied and the stages of decay defined.

The paper serves as a useful key for the identification of wood rots and also to determine whether the organism is only a stain producer or a wood destroyer. It has been well illustrated and includes references to a large bibliography.

Preventive measures have not been dealt with.

A. H. K.

A NEW VOLUME ON THE FAUNA OF BRITISH INDIA.

THE FAUNA OF BRITISH INDIA; COLEOPTERA; EROTYLIDÆ, LANGURIIDÆ AND ENDOMYCHIDÆ, by G. J. ARROW. Taylor and Francis, London, 1925. PP. 416; figures, 76; 1 coloured plate and one map. Price 30*s*.

The latest addition to the *Fauna of British India* series is a volume dealing with the three families of beetles, *Erotylidæ*, *Languriidæ* and *Endomychidæ*. These insects are especially characteristic of forests as part of the fauna of damp decaying wood and bark and of the associated saprophytic fungi; some of the *Languriidæ* feed as larvæ in the stems of living plants.

That the systematics of these families have been dealt with by Dr. G. J. Arrow of the staff of the British Museum and one of the leading authorities on lamellicorn and clavicorn beetles is a sufficient guarantee for the scientific value of the work. The editors have introduced two new features not present in former volumes of the series, (1) a folding map of India and Ceylon, which is the result of a widely expressed demand, and (2) a short index of the plants recorded in association with the species of insects, rendered possible by the increased attention paid by collectors to their bionomics.

Forest officers in India whose tastes incline towards some aspect of natural history are generally more attracted to birds or butterflies or botany; and naturally so by reason of

the more abundant literature and the greater ease with which their captures can be named and classified. But the existence of these facilities tends to obscure the needs of the enormously greater and far less intensively surveyed field of forest entomology, which continuously cries for more workers, professional and amateur.

It is gratifying, therefore, to notice the names of seven forest officers among those who have contributed to the material on which Dr. Arrow has worked:—Messrs. T. R. D. Bell, H. G. and F. W. Champion, R. N. Parker, C. R. Robbins, G. Rogers and O. H. Walters.

C. F. C. B.

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AIR RECONNAISSANCE OF THE FORESTS OF SOUTH TENASSERIM DIVISION.

The following brief account of the work carried out during the season, 1924-25, with a resume of the results may be of interest. It is hoped to publish fuller details with reports of the officers in charge of the operations shortly.

Introduction.—The very successful aero-survey of the forests of the Irrawaddy Delta in 1923-24 gave little opportunity of experimenting with the use of an aeroplane for survey or reconnaissance of hill forests. The forests in the Delta are situated on level land and are of a peculiar type found only in country within the influence of tides. With the organisation ready to carry on the work on the spot it was thought that the opportunity of making a more extended experiment on the uses of aeroplanes in the photographing from the air and general reconnaissance of forest areas should not be lost and proposals were submitted for the aero-photography of 613 square miles of the Heinze and Kaleinaung reserves in the South Tenasserim Division and the aero-reconnaissance of the remaining 14,000 square miles of the South Tenasserim Division in the Districts of Tavoy and Mergui. The whole of this area had recently been completely surveyed by the topographical branch of the Survey of India and 1" maps of the area were available. The air operations in Tenasserim, therefore, differed fundamentally from those in the Irrawaddy Delta in 1923-24. In the Delta, the topographical mapping of an unmapped area was the primary object, and the forest stock-map-

ping achieved simultaneously was an important but secondary result. In Tenasserim, the forest stock-mapping was the primary and only object.

Contract.—Since the completion of the Delta Aero-Survey the organisation created by Mr. Kemp has been formed into a company under the title of the Air Survey Company Ltd. Sanction for the work and a grant of the necessary funds was obtained from the Legislative Council and a contract was drawn up with the Company on the following lines :—

(1) Photographic Survey of the Kaleinaung and Heinze reserves in the South Tenasserim Forest Division. Reconnaissance and production of vertical and oblique photographs taken from air-craft necessary or suitable for the compilation of a map showing the different types of forests. *Contract for Rs. 1,07,888.*

(2) Reconnaissance survey of the whole of the country in the Tavoy and Mergui Districts in the South Tenasserim Forest Division excluding the area under (1) (some 14,000 square miles). Contract for Rs. 58,322.

The maximum flying time available under the reconnaissance portion of the contract was 50 hours. At the same time it was considered possible that the first part of the contract would not prove to be of sufficient additional value to justify the photography being carried out over the whole area under the contract and it was provided that photography under part (1) might be given up in exchange for extra flying time under part (2) should it be found advisable on the ratio of one flying hour on reconnaissance = 20 square miles of photography.

Personnel.—It was arranged that for the reconnaissance, the mapping should be carried out by a Forest Officer acting as observer and the Department was fortunate in possessing two officers—Messrs. C. W. Scott, D.F.C., and C. R. Robbins, M.C., D.F.C.—who had both had considerable experience of flying and observing during the war. Both these officers were placed on special duty for the season from November to the end of April

and to them must be given the chief credit for the successful operations of the year.

The pilot employed by the Air Survey Company was Major Cochran-Patrick, D.S.O., M.C., who had piloted so successfully in the aero-survey of the Delta in the previous year. As in the previous year, Major Cochran-Patrick carried out the task with great skill and judgment

Brief description of the country.—Very little was known of the forests of South Tenasserim before the commencement of operations. It was known that there were vast evergreen forests and somewhat exaggerated estimates of their possible yield had been made. It was believed that they held enormous stocks of valuable timbers with sufficient tonnage per acre to justify logging on a large scale. The tract covers a strip of land varying from some ten to seventy miles wide and three hundred and fifty miles long lying between Siam on the east and the Bay of Bengal on the west and fringed by a number of islands more especially in the southern portion where numerous islands of all sizes up to 20 square miles or even more form what is known as the Mergui Archipelago. The area is given in the census of 1921 as 15,097 square miles but at that time many of the 1″ to 1 mile maps had not been completed and even now some of the large islands are unsurveyed so that the total is probably nearer 16,000 square miles. The area is terminated in the south at Victoria Point by the Pakchan River which marks the border of Siam.

In the broadest portion of this strip of country there are big valleys running parallel with the coast—the Tavoy River in the north, the Big and Little Tenasserim rivers in the centre and the Pakchan River forming the boundary of Siam in the south. These rivers in their lower courses are of considerable width and in view of the possibility of engine failure while out of gliding distance from the sea, gave a fair chance of safety in the event of a forced landing. There were, however, large areas of forest outside what could be considered safe gliding distance from the sea or the larger rivers and special instructions were given that the reconnaissance of these areas was to be less detailed and that the flying outside a safe gliding limit from the landing places was to

be avoided as much as possible. In view of the remoteness of such forests, the possibility of the commercial development was small and detailed reconnaissance was therefore unnecessary.

Configuration.—The country is hilly with hills rising to 7,000′ (Nwalabo *taung*) and 5,000′ to 6,000′ on the Siamese frontier. The majority of the hill ranges do not stand up to more than 2,000′ to 3,000′ though peaks of 3—4,000′ are common. On the whole, the slopes vary from steep to very steep but are considerably easier to the south and nearer the coast.

Description of the operations.—Flying was delayed until January owing to the necessary equipment not having arrived in time. The Forest Officers on special duty—Messrs. Scott and Robbins—were posted early in November and the time before the commencement of the actual flying operations was employed in examining various portions of the area from the ground with a view to describing the different types of forest. Some very useful exploration work was undertaken and a number of types described and determined. The actual flying operations were commenced in January with the photography of the Heinze and Kaleinaung reserve but Mr. Scott, who throughout was in charge of the operations and was given full powers to exercise Government's option to transfer photography to flying time on reconnaissance, soon decided that the most useful results would be given by reconnaissance. It was, therefore, decided to confine photography to two representative strips in the Heinze and Kaleinaung reserves, each 4 miles wide and 25 miles long and to other strips representative of the different types in other portions of the area, and to transfer the unused balance of the photography to reconnaissance. The strips photographed give all that is necessary for experimental purposes to show the advantages and disadvantages of aerophotography.

As a result of giving up part of the aerial photography some 21 extra hours of flying time were transferred to reconnaissance and allowed for a very much more thorough examination of the area to be undertaken. The whole of the actual reconnaissance stock-mapping from the air was carried out by Mr. Robbins. As an observer and pilot in France during the late war, he had

extensive experience of artillery observation from the air and was able to distinguish the forest types and mark their boundaries on the 1" to 1 mile map with great speed and accuracy, producing an excellent forest stock-map. Mr. Scott rendered invaluable service by checking Mr. Robbins' result from the air and from the ground and generally in the control and direction of the operations.

Reconnaissance was carried out from four bases along the coast. Unfortunately bad weather conditions were experienced in March and it was not, therefore, until about the middle of April that the reconnaissance was actually completed ; by then weather conditions were so bad that in any case no further work could have been carried out. The seaplane used was the same as had been used in the Delta aero-survey in the previous year and was a D.H. 9 Puma engined service type aeroplane, converted for use as a seaplane by the addition of floats.

A motor launch belonging to the Air Survey Company proved invaluable for transferring from base to base.

Results.—The results of the aero-survey of the Irrawaddy Delta in 1923-24 have been published as "Burma Forest Bulletin No. II" and it is hoped to publish full reports and results of last season's work shortly.

The following brief summary of results of the season's work may be given here :—

(1) A stock-map for some 15,178 square miles of forests showing the distribution of 13 different types of forest has been obtained in one season at a cost of Rs. 5-5 per square mile. It is estimated that it would have taken twenty years and cost at least Rs. 15 per square mile to have examined the same area from the ground with sufficient thoroughness to have produced a stock-map on the same lines. A comparison of the reconnaissance map with the stock-map actually prepared on the ground during the past season in the Heinze and Kaleinaung reserves by the working plans party under Mr. H. C. Smith shows that they agree in essentials and the differences in detail are so unimportant as to be negligible. The reconnaissance map occasionally fails to show small differences in sub-types where it would only be possible to

distinguish these on the ground by a knowledge of the more typical species or by comparing the actual size of the trees. To quote Mr. Robbins—

" In fact in all cases where there are disagreements which might prejudice the value of the aerial method they are in a manner sacrifices to the necessity for speed. In most cases, the observer has recognised the types but, considering that the fixing of their boundaries did not justify the time, has lumped the smaller patches with the larger blocks, and made a note to that effect. In most cases the aerial method has distinguished the larger patches of such types as scrub and riverine, which rarely appear other than in small areas. The necessity for economy of time has here also rendered the boundaries not strictly accurate.

" The ground method has supplied a large amount of information as to species in comparison with which the observer's little notes of 'much *shitle*,' 'some *pyinma*,' 'probably plenty of *pyingado*' make a very poor show. This and other silvicultural information are of such paramount importance for working-plans that the aerial reconnaissance method is unlikely to supplant the ground method. The broad lines of the maps produced by the former method are eminently suited for preliminary surveys or for reservation proposals but they are not sufficiently detailed nor backed by other information to provide a basis for a scientific plan of management."

Aerial reconnaissance of forests and the ordinary examination from the ground are not rivals; the former is in some cases extremely valuable as a preliminary to the latter and as a time and money saver, indicating the areas which are worth and those which are not worth early examination from the ground.

(2) Sufficient photography has been undertaken, mainly on 2 strips 4 miles wide by 25 miles long in the Heinze and Kaleinaung area and on other smaller strips elsewhere, to illustrate the different types of forests and render the comparison between the various methods of ground reconnaissance, air reconnaissance and aerial photography possible. The cost of aerial photography was high, approximately Rs. 160 per square mile.

(2) Based on the results of the air reconnaissance a definite programme for reservation and proposals for dealing with the question of *taungya* cutters can be drawn up. One of the most striking results of the reconnaissance is to show the enormous area that has been laid waste by *taungya* in the past and the extent to which forest is now being destroyed. Steps can be taken immediately to restrict the area cut over by the free use of *Rule 19, prohibiting taungya cutting over certain areas.*

Conclusions.—In spite of some misgivings as to the results of the operations previous to their commencement they may be considered a very great success and in addition to the valuable information as to the distribution and types of forests in South Tenasserim, the general experience of the work at this experimental stage should have a very great value far beyond its actual value to the Province even though there can be little question that this has fully justified the actual expenditure incurred.

A HYBRID TERMINALIA (*ARJUNA × TOMENTOSA*); AND SOME GENERAL REMARKS ON TREE HYBRIDS.

In January last Mr. R. P. Dalley sent some leaf-specimens which came from a tree he said was called locally in the East Khandesh division *arjun* and distinguished from *kahu* by natives. Both these names are usually used for *Terminalia arjuna* but he stated that the *arjun* looked more like *T. tomentosa*. A similar question had been raised in North Khandesh in 1918 as to two trees called *arjun sadada* and *kahu*. Both Dalley's specimens and the ones from North Khandesh looked more like *T. tomentosa* than *T. arjuna*, but appeared to be of hybrid origin.

MacDougal, Hybridization of Wild Plants (Bot. Gaz. 43, 1907, p. 45) states that in order to decide whether a plant showing characters intermediate between two species is of hybrid origin three methods of investigation are available. One is to reproduce the hybrid by artificial fertilization from its supposed parents. Another method is the anatomical examination of the hybrid and its supposed parents. Thirdly the raising

of second and if necessary succeeding generations of the supposed hybrid in order to see if the ancestral characters reappear.

Henry and Flood, The History of the London Plane (Proc. Roy. Irish Acad. 35 B 2 (1919)) rely on the last of these methods alone coupled with exceptional vigor as being satisfactory proof of hybrid origin. In the case of trees, the raising of seedlings of the second generation if it leads to positive results seems to be sufficient proof, and all that can be done in a reasonable period of time. Most tree hybrids have been accepted as such without even this precaution.

To produce artificial hybrids of trees has obvious difficulties and moreover since reciprocal crosses are not necessarily identical a negative result would be inconclusive. Crossing may take place in nature under exceptional circumstances which even if known may be difficult to reproduce. Some years ago when studying willows in Chamba I came across several individuals which appeared to be hybrids between *Salix denticulata* and *hastata* since they were intermediate in appearance between these species and were found in thickets composed almost entirely of them. A serious objection to the hybrid theory was that in this locality in July though *Sadix hastata* was flowering freely *S. denticulata* was over and shedding its seeds. Cross fertilization between these species seemed therefore impossible. Eventually I came upon a stray plant of *S. denticulata* which had just been exposed by the melting of snow in the ravine in which it was growing. The plant was a female and in full flower. In this case it was obvious that if the plant was pollenated the pollen would almost certainly come from *S. hastata* since, except for a similar accident there would be no pollen of *S. denticulata* available. I think it is very probable that in the nature hybrids mostly result from some such unusual set of conditions. Any interference with the normal development of a plant such as cultivation seems to favour the appearance of hybrids. In the Himalaya I have never seen an undoubted hybrid *Berberis* but in cultivation in Europe the species of *Berberis* hybridize with the greatest ease. A probable hybrid *Albizzia* is now being grown but it will be some years before seed

can be obtained from it. This plant appeared amongst a batch of seedlings of *Albizzia lucida* from a tree cultivated in Dehra. It is obviously not *Albizzia lucida* nor does it appear to be any of the indigenous species of *Albizzia*.

As regards the anatomical tests suggested by MacDougal these if they led to anything would only give evidence similar to that far more readily obtained from morphological features. In the case of the hybrid *Terminalia* it would involve the examination of similar organs from *T. tomentosa*, *T. arjuna* and the hybrid. I believe anatomical features to be far more inconstant than is often supposed. In the case of the Coniferæ the position of the resin ducts whether marginal or median is relied on to distinguish similar species. I have found specimens of *Pinus densiflora* grown in the Himalaya with half the resin ducts median and half marginal. A pine grown in Dehra and received from Saharanpur as *Pinus cubensis* was obviously not that species but until it produced a cone showing that it was *P. longifolia* I could not tell what it was. Large numbers of needles were examined and in no instance was a resin duct found and the number of endoderm cells seemed to be much too small for *P. longifolia*. In *Abies Webbiana* (the High Level Silver-fir of the West Himalaya) I have found the resin ducts marginal or median or one marginal and one median. In no other family of flowering plants are anatomical characters used for systematic purposes to the extent that they are in the case of the Coniferæ. As in the Coniferæ though extremely useful in most cases, they are liable to break down, in other families which have been far less studied the constancy of anatomical characters should be looked upon with suspicion. It is only fair to add that MacDougal himself does not seem to advocate the anatomical method.

As regards the third method this has been tried in the case of the Khandesh *Terminalia* with positive results. The seedlings of *T. tomentosa* and *T. arjuna* can be distinguished as soon as the cotyledons appear (*vide* Troup Silviculture of Indian Trees, plates 201 and 202). Mr. Dalley sent seed taken from two trees locally called *arjun sadada* (*i.e.*, the name used for the

specimens from N. Khandesh in 1918) and stated that he had only seen one of the two trees and that it looked more like *T. arjuna* than the one from which he had previously sent leaf specimens but that characters of *T. tomentosa* were also evident both in the leaves and in the bark. He added that such trees were scarce which is to be expected of hybrids.

The seed was sown in Dehra Dun in July and germinated very freely. The hybrid origin was at once apparent, one or two seedlings had the cotyledons raised well above the ground as in *T. arjuna*, a good many seedlings had the cotyledons appearing from below the ground level as in *T. tomentosa* but the majority were intermediate tending to *T. tomentosa* rather than *T. arjuna*. It would have been better had the seed all come from one tree instead of from two trees but the fact that it came from two trees does not affect the result. The seedlings cannot be divided into two groups or even into three groups as there is a regular series ranging from *T. tomentosa* to *T. arjuna* with the number of individuals decreasing from *T. tomentosa* to *T. arjuna*. Mr. Dalley remarked that one of the two trees from which the seed came looked more like *T. arjuna* than *T. tomentosa* but the fact that majority of the seedlings approximate to *T. tomentosa* shows that this species is the dominant parent in the cross.

This method of raising second generation hybrids (assuming of course that the parent tree is a first cross) does not always lead to positive results. Some hybrids breed true so that in the present case had the seedlings all come up alike this could not have been taken as definite proof against the parent being a hybrid. A peculiar form of *Ehretia buxifolia* found by me last year in the Lahore gardens is now being grown from seed. The plant shows certain characters not found in any wild specimen of *E. buxifolia* I have seen and also certain differences in leaves and growth. If a hybrid it is very much more like *E. buxifolia* than any of the other species of *Ehretia* grown in Lahore. About a dozen seedlings have been raised and they are all like the parent plant showing no separation of characters but they have not flowered as yet. Though in this case a hybrid origin of the plant is not excluded the seedling evidence tends to show that

it is a " sport " as is also probable from the morphological features Sports like hybrids seem to be commoner in cultivation than in nature and there are many cultivated plants which do not fully correspond with wild species and have doubtless originated as sports in garden.

R. N. PARKER,
Forest Botanist.

LOCAL SEEDS *V.* FOREIGN SEEDS.

When starting plantations of species which are not indigenous the question arises whether it is better to use seeds of trees already growing in the same district or to indent for seeds from the home of the tree, regarding which opinions differ. The results of some experiments made in Srimangal Reserve, Sylhet, Assam, by the writer in regard to teak may be of interest to your readers. Teak seeds were obtained from both local trees (Sylhet) and from Burma and observations made on the difference of growth. There is an idea prevalent that seeds from local trees having become acclamatised will produce better plants. It may be true in case of fruit trees, which may be specially nurtured, but there is no doubt that in case of timber trees which cannot obtain the same attention after they have grown beyond a certain height. The seeds of acclamatised trees may germinate more readily and in greater profusion but it is found from actual experience that the trees degenerate before maturity.

LOCAL SEEDLINGS.	BURMA SEEDLINGS.
Seeds sown in April. Height-growth in October, tallest seedlings 18 inches. Average seedlings 6 inches.	Seeds sown in April. Height-growth in October. Tallest seedlings 6 feet. Average seedlings 3 feet.
Growth stopped in November and plants leafless in December, many being apparently moribund.	Growth continued till January, the leaves persisting till the middle of March, a few lasting throughout the cold weather.

Fig. 1. Comparison of growth of Assam and Burma teak.

Fig. 2. Lac on *Leea crispa* in Khasi Hills.

Growth restarted in May, terminal buds having dried, shoots frequently started from low down on the last year's shoot. Growth slow.	Shoots started from terminal bud straight away in April and growth continued rapidly.
Leaves small and obovate and dark green in colour, weak. New leaves yellowish green with a slight tinge of violet, tough.	New leaves large obovate to elliptic-obovate, dark violet to yellow in colour, drooping and have a graceful appearance.
New shoots thin and roundish in section.	New shoots stout, distinctly quadrangular in section with depressions between the angles.
Axillary buds appear at each leaf axil.	Stem remained clear of axillary buds.
Manure produce slight improvement.	Manure not being required was not employed.

It is worth noting that a few of the local seedlings have flowered within a year of planting. The age of these seedlings is 24 months from the date of germination.

Seeds were sown in two beds side by side exactly under the same conditions. The enclosed photograph shows the difference, the local seedlings are on the right and those from Burma on the left of the photograph. (Plate 32, Fig. I.)

The poor success which has attended the creation of some teak plantations in the past may perhaps be attributed to forest-officers and others using seed from local trees.

B. SEN GUPTA.

CULTIVATION OF LAC IN THE KHASI HILLS, ASSAM.

In most parts of India lac is found on trees growing more or less wild either in forests, waste lands or dotted about in cultivation.

The practice of jhuming is prevalent on that long stretch of mountainous country which divides the two valleys which constitute the Province of Assam. Along with other crops *arhar dal* is cultivated on jhums as a host plant for the lac insect and a wild herbaceous shrub (*Leea crispa*) is also impregnated to yield an autumn crop while the lac on the *dal* is harvested in the early part of the hot weather. The *dal* plant (*Cajanus indica*) may be used for both summer and rains broods but the *Leea* is only used for the rains crop.

The recent high prices for lac have stimulated an enterprising planter to lease a large area and plant it with *Leea* which yields a very heavy crop of lac in the autumn. This plant is easily propagated by division of the rhizomes, which are not unlike those of the tree *Dahlia* (so called) and yields stems ready for inoculation three years after planting. The shoots which are about ten feet in length persist for one and a half years. The young thick fleshy shoots are of a red, blue and pink colour. They grow with great rapidity early in the rainy season reaching full size in about two months. The individual shoot persists through the first cold weather producing flowers in twelve months and berries four months later and then dies down in the following cold weather.

The stems are impregnated about June of the second year when they come into flower, from lac which is harvested at this time from the *dal* plants, tiny bamboo baskets

containing a few ounces of the broken lac being used for the seed as well as stalks with lac which are tied on. The insect after distribution settles down and in two or three months the branches of *Leea* look as if they were covered with heavy masses of cotton wool so white as to be positively dazzling. The photograph (plate 32, fig. 2) shows this striking phase in the life cycle of the insect. The stems are cut to harvest the lac about October-November when the winter impregnation is at once taken in hand. The *Leea* is a fairly common plant and is usually found in rocky ravines and steep hillsides where it can get plenty of light, it does not actually occur in the plains but does well anywhere above the 500 feet level where there is good rainfall. Another wild plant *Flemingia congesta* is preferred by the planter Mr. Gregory of Umran to *Cajanus* and will yield both rains and winter broods, but is used for the latter alternately with the *Leea.* It is of an upright habit growing to a maximum of seven or eight feet in height and has a deep root system which enables it to survive periods of drought better than the more shallow rooted *Cajanus.*

The lac has numerous enemies to contend with such as birds, ants, parasites and defoliators not to speak of thieves. The ground round the plants has to be kept hoed up and ants' nests destroyed and defoliating grubs picked. Fire is an enemy where the ground has not been kept clean and did much damage in the second year of the plantation. Drought is the cause of much loss but can be obviated to some extent if the winter crop is grown in the moist hollows between ridges. A black fungus tends to smother the growing lac in shady localities and in cloudy weather.

Patrols look after the lac during the growing season, each patrol looking after a certain number of plants.

The lac grown on these herbaceous plants is not of so good a quality as that obtained from *kusum* or *palas* trees of which the writer has had some experience in Chota Nagpur.

F. T.

SILVICULTURE AND THE APPLICATION OF THE SILVICULTURAL SYSTEMS IN *AUSTRIA AND BOHEMIA*.

There was a time in the history of the Central European forestry when the forester largely believed in growing pure even-aged crops. Transformation of the natural mixed crops into pure crops used to be the rule and clear cutting and planting was considered in many places to be the ideal forestry. Time and experience, however, soon taught the forester that his ideal of forestry really meant discontinuity of forestry in the long run. The forest soil under his system of management deteriorated; as firstly the thick and homogenous compact layer of undecomposed humus under pure crops cut the supply of air and moisture from the soil, secondly the roots of the same species in the even-aged crops tapped the same layers of the soil and thus made it poorer and poorer every time at a particular depth, thirdly after every clear felling the soil always suffered from the effects of the exposure for quite a long time before the young plants could form a complete canopy, and lastly on a clear cut area a thick growth of rank grass and brambles made it very hard for the young plants to get sufficient nutriment as the upper layers of the soil were always monopolised by the roots of the rank growth.

Recent investigations have also shown that the bacteria that help in improving the soil die off on the forest soils that remain exposed to the extremes of temperature for a length of time and that the proper aeration of such soils being completely destroyed, the rank growth of grass encourages the multiplication of the unfavourable bacteria.

Further, the pure crops could not withstand the heavy winds and, therefore, extensive areas of such forests were simply broken down and devastated by windstorms and then the insect pests almost invariably followed the wind calamities and completed the scene of ruination of the forest areas. A typical example of the last case is to be seen in Reichraming and Kleinreifling near Weyer (Austria), where in 1917 a windstorm made a clean sweep of a forest area under pure spruce to the extent of over 10,000 acres in about half an hour's time and later the Scolytid beetle came in and affected as much area again in the neighbourhood of

Fig. 1.

Strip fellings (Kahlstreifenschlag) running at right angles to contours in a mixed larch, spruce and silver fir forest near Leoban (Austria).

Fig. 2.

Initial stages of natural regeneration under Shelterwood System (Schirmschlag) in a mixed black pine, oak, and beech forest at Markenstein (Austria). Notice herringbone tapping for resin on the pine trees.

Fig. 3.

Advanced stages of natural regeneration under group system in a mixed pine, silver fir and beech forest at Frohnleiton (Austria).

the wind-broken area. The total volume of timber thus affected has been estimated to be 35,000,000 cu. ft. over an area of 20,000 acres. Another example of a similar case can be seen at Ernstbrunn in Bohmerwald (Bohemia) where about 7,000,000 cu. ft. of spruce timber was broken down by wind over an area of about 10,000 acres.

The forester has, therefore, now realised that going against nature is an unnatural way of doing things in forestry, that a *system of treatment applied to a forest should be such as should* suit the type and the natural requirements of the forest and that no attempt should be made to convert a forest to a particular system unless the species of the forest admitted of it. The old ideals of forestry in Central Europe have, therefore, taken a turn and at present conversion of the artificial pure crops back into the original mixed crops has become a general rule.

The most important forest species of Central Europe are: Spruce, larch, silver-fir, scots pine, black pine, and cembran pine amongst the conifers, and beech, oak and birch amongst the broad-leaved. Of these the spruce is the greatest in demand and, therefore, one finds extensive areas under artificially raised crops of spruce throughout Austria and Bohemia, which, of course, are now being transformed into mixed crops by certain methods as described below:—

(a) Transformation of pure spruce crops into mixed crops.

1. In poor soils where natural regeneration of spruce cannot be relied upon, strips of 20 to 30 yards width, to start with, are cut through a mature crop every here and there, taking into consideration the direction of the prevailing winds, aspect, transport facilities, etc. Such strips are then planted up with spruce. The seed falling from the adjoining trees is also expected to help to a certain extent in making up for the casualties amongst the plants. Simultaneously with or directly after the strip fellings a number of openings, about 25 yards in diameter, are made inside the areas next to the strips, proceeding always against the direction of the prevailing winds. Such openings are made over a strip of about 100 yards width with a distance of about 50 yards between each opening, and then planted up with beech

silver-fir and larch, these species being the usual associates of spruce in natural crops. As soon as the plants have established themselves in the groups as well as in the strips the rest of the trees round the groups are clear-felled and the area planted up with spruce. At the same time fresh group fellings and strip fellings are made in the adjoining area, and plantations carried out as before. Thus the same process is repeated till all the old spruce trees are removed and replaced by young plants of spruce in strips, and of beech, silver-fir and oak in groups. If the area happens to be a large one then it is divided into a number of cutting sections and each section undergoes the above process of transformation simultaneously. The average length of time taken to complete the transformation is reckoned to be 25 years.

This method was seen in operation in the Altiergarten, the Ernstbrunn and the Mader Reviers of Bohmerwald (Bohemia) and in the Frohnleiton and Weyer Reviers in Austria.

2. In good soils where natural regeneration of spruce can be relied upon, a heavy thinnings over a strip of about 20 yards width is made to start with, and then fellings in groups over a *strip of 100 yards width, in the adjoining area, are made in the* same manner as described under (1) above. The group openings are planted up with beech, larch and silver-fir and in some cases with oak as well. At the same time a light seed felling is made all round and in between the groups with a view to get natural regeneration of spruce. Now as regeneration, natural as well as artificial, shows progress fellings over the area are made more and more heavy, till ultimately all the old spruce trees are removed and replaced by a mixed young crop. Further progress is made year after year by further extending the group fellings in the adjoining area, proceeding always against the wind in windy localities, and against the sun (north to south) on dry aspects, or in the direction best suited in localities which may be subject to both of these dangers. In case of large areas the fellings are distributed over a number of cutting series and the process of transformation is thus quickened. The whole area is thus regenerated into a

mixed forest partly artificially and partly naturally in about 20 years time.

This method was seen being worked in the Tusset and the Schattawa Reviers in Bohmerwald (Bohemia) and in the Pollergrabin Revier (near Leoban) and the Kleinreifling Revier (near Weyer) in Austria.

(b) Regeneration under mixed forests.

There are a number of different methods which are being applied for obtaining natural regeneration in mixed crops and the ones that are mostly favoured at present are : (i) Schirmschlag (Shelterwood system), (ii) Gayer's Femmelschlag (Group system), (iii) Wagner's Blendersaumschlag (small strip fellings starting from the north), (iv) Kahlstriefenschlag (clear felling in strips), and (v) Kubelka's Femmel-Streifen-Schirmschlag (combination of Femmelschlag and Schirmschlag in strips). Now-a-days one, however, very seldom finds anywhere in Central Europe any one method being strictly followed in its minute details according to the bidding of the author, and variations, modifications, and combinations are invariably resorted to in order to suit the particular requirements of each individual locality. In most cases one finds almost all these methods being applied in one and the same working circle and even in the same compartment, throughout Central Europe. The fellings that are carried out annually are, consequently, of a very scattered nature, but this fact does not worry the forester as there are always a network of roads and plenty of means of transport provided in his forests. In fact, it is considered to be an advantage to have the annual yield realised by making small fellings every here and there as a safeguard against windstorms and for other reasons.

The following commentary on the application of each of the above-mentioned methods will be of interest here :—

(*i*) *Schirmschlag.*—The area to be regenerated is first subjected to a seeding felling under which about one-fifth of the crop is removed. It may be noted that the preparatory fellings are not generally considered necessary as the final thinnings serve the purpose of the preparatory fellings. After the seeding fellings the

standing trees are expected to develop good crowns and the ground is expected to become a good seed bed within about 5 years time and then within the next 5 years seed having fallen from the trees regeneration is expected to have started coming up, so that 10 years (with two good seed years) after the seeding fellings an intermediate felling is carried out, under which almost half of the standing trees are removed. Then again 5 years later another intermediate felling is carried out in areas where regeneration is still wanting and final fellings in areas where regeneration has been completed. In some areas there may be as many as three or more intermediate fellings necessary before the final felling is made. This, therefore, shows that no hard and fast rules are followed strictly and the various operations prescribed under the system are not carried out only mechanically: Success in obtaining natural regeneration is aimed at and the forester endeavours to obtain it in any manner that may be possible. Ordinarily it is expected that the areas will be completely regenerated within about 15 years time but to be on the safe side a period of 20 years is allowed before final fellings are made over the whole area. In case of blanks planting work is resorted to and this generally amounts to about 10 per cent. of the total area on an average.

This method is very well exemplified in the Plockenstein and the Neuthal Reviers in Bohmerwald (Bohemia) and in the Kletsbach (near Frohnleiton) and the Seebenstein (near Vienna) Reviers in Austria.

(*ii*) *Gayer's Femmelschlag (Bavarian Method)*.—In this case the first fellings are invariably started from the openings which may have been caused by winds or other agencies and in such openings regeneration is almost always found to have started already. Therefore, one begins gradually extending such openings by making fellings all round them, and as regeneration progresses one makes further fellings in more or less concentric rings. Such fellings are generally repeated every five years till finally in 20 years time all such groups of the whole area meet together and the old trees are replaced by young regeneration.

This method, although not altogether independently worked anywhere now, is, however, very freely applied in combination with other systems throughout Central Europe, and is said to have an advantage over the Schirmschlag in that under this modified method, there is less danger of winds doing damage to the standing trees and also the young seedlings thrive better under side shelter with no overhead cover. Moreover, this system is considered to be more suitable for regenerating mixed crops than any other.

Typical examples of this method as applied at present, are to be seen throughout the Bohemian Forests and one showing the most successful results is in the Altiergarten near Budweis (Bohemia).

(*iii*) *Wagner's Blendersaumschlag.*—Wagner advocates fellings to be started always from the north side of the forest and in very narrow strips (about 8′ in width). He bases his theory chiefly on the moisture requirements of the young seedlings and wants to protect his seed bed and the young plants against the injurious effects of the sun, and, therefore, he is very imperative about maintaining shelter from the southern side. His observations, however, are wholly based upon the experiments that he has carried out in Gaildorf, and it is very seldom that his point about the north side fellings is adhered to anywhere else in Europe. The principal about proceeding with the fellings very gradually in narrow strips (with three zones of fellings, *i.e.*, one strip undergoing the seeding fellings, the other undergoing the intermediate and the other the final fellings) is followed in many places, but the fellings instead of proceeding north to south, proceed generally against the prevailing winds in the plains and from top to bottom (at right angles to the contours or at any other angle with a view to find a compromise between the wind danger and the extraction difficulties) in the hills. In every case, however, this modified method is worked in combination with other methods in Bohemia and Austria. As the progress of regeneration made under this method is very slow at one place, the area in hand is, therefore, generally

divided into a number of cutting sections and the fellings are carried out from so many different fronts.

Examples of this modified method are to be seen almost throughout the Bohmerwald forests.

(iv) Kahlstreifenschlag.—This method was the first to succeed the ordinary Kahlschlag (clear felling). As applied in Central Europe, the fellings under this system are carried out in alternate strips about 150 ft. wide (twice the height of the trees approximately), the unfelled strips being only about 50 ft. wide. Regeneration is expected from the seed falling from the trees of the unfelled strips and also from the seed bearers (about 10 per acre) that are left standing on the felled strips. Generally such trees from amongst the principal species are selected as seed bearers which have a tap root or are otherwise windfirm. These trees are felled as soon as regeneration has appeared on the ground, within about 5 years of the main fellings, after which the existing regeneration is supplemented by planting or dibbling. The unfelled strips are felled last of all and planted up artificially. This method is now mainly applied in the hill forests, where the strips generally run at right angles to the contours with a view to facilitate transport. It has an advantage over the ordinary clear felling method in that it does not expose the soil to the sun and the climatic influences to the same extent as the clear felling does. Moreover, under this system about 60 per cent. of the area is naturally regenerated.

The Schottwein and the Leoban forests in Austria offer a very good example of this system.

(v) Kubelka's Femmel-Streifen-Schirmschlag.—As the name suggests it, the method is a modification and combination of the group and the shelterwood systems. An operation of the nature of a light seed fellings is first carried out all over the area to be regenerated, and then in the same year a group felling is made in alternate strips, which latter are about 50 yards in width and run parallel to each other about 50 yards apart. Distance between the group openings in the same strip is also kept about 50 yards. The idea is to get natural regenera-

tion more quickly than under the ordinary group system and without having to expose the area to the winds and the sun as uninterruptedly all over, and to such an extent, as is generally done under the uniform system. The group fellings are arranged in strips chiefly with a view to facilitate extraction.

During the course of the first 5 years as soon as regeneration starts appearing in the openings, the groups are extended centrifugally as is done under the ordinary group system, and as the trees in the rest of the area start regenerating themselves gradually after the light seed fellings, and also keep becoming more and more windfirm, further and heavier fellings are carried out. About 5 years later the groups are still further extended and at the same time an intermediate felling is made in the rest of the area. In another 5 years time regeneration in and between the groups (*i.e.*, all over the area) is expected to be completed, and, therefore, final fellings are made all over the area, and thus the whole forest is completely regenerated within about 15 years time.

Apparently the method is becoming very popular with the young school of foresters in Austria, as it has the advantage of having taken in itself all the good points of both the Femmelschlag and the Schirmschlag systems. The chief point of it, however, is that regeneration is obtained more quickly than under any one of the two systems individually.

This method was seen being applied to a mixed forest of spruce, silver-fir, and beech in Markenstein (about 50 miles from Vienna), where it has given very successful results, and where no planting has been considered necessary to supplement the natural regeneration obtained.

General Remarks,

The working plans in Central Europe are punctually revised usually every 10 years and most of the important forests (Private or Government) have been under systematic management for hundreds of years. Stock maps as old as 150 years, with a revised picture for every 10 years drawn up to date and with a complete history of each crop of such forests recorded on them are often available in the offices of the respective Forest Directors.

The question how possibility is calculated under the systems described above will be discussed in a separate article, but it will not be out of place to mention here that the yield is fixed for the full period of the working plan principally by area, with an elaborate volume check and in comparison with the normal yield. Calculation of yield by volume to almost exact figures is a question of no difficulty in Central Europe, as the forests are generally wonderfully well organised and are more or less normally stocked. Although considered to be a bit more laborious the area-cum-volume method has, however, very great advantages over the ordinary area method in the Continental forests, as the utilization of wood of almost all species of those forests is very intensive ; the forest staff and the forest labour are fully qualified and skilled, and the roads and means of transport (mechanical and otherwise) are available to the fullest extent.

The local Forest Officers (Divisional Forest Officers) have more or less a permanent association with their respective Reviers (Divisions) which generally average to about 10,000 acres each in extent, and, therefore, are generally allowed a very great discretion in carrying out the provisions of the working plans. They can deal with each unit of their respective charges in the manner they consider best for the time being in view of the existing silvicultural requirements of each case and also in view of the prevailing conditions of the market at any one time during the working plans period, provided only that they fell not more than the yield estimated and prescribed for the period of the plan within the period.

MOHD. ZIA-UL-HAQ,
D. F. O., Pilibhit, U.P.